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DEVELOPMENT OF THE ORDER-TO-DELIVERY PROCESS FROM A TRANSPORTATION PERSPECTIVE

Master of Science Thesis

Examiner: Assistant Professor Heikki Liimatainen
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ABSTRACT

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An efficient order-to-delivery process is an important competitive factor for a company's operations. In this thesis, the focus is on the transportation-related challenges and development targets of the six units of Metso Minerals. As transportation is related with several sub processes in the order-to-delivery process, virtually the whole process was considered in the thesis. The main objective was to find out how the order-to-delivery process could be developed to become more transparent and cost-effective, and enable Metso Minerals to offer better service to customers and ensure quality. This work serves as a basis for future development projects of the order-to-delivery process at Metso Minerals.

The theoretical part discussed the order-to-delivery process and supply chain management. In addition, logistics as a vital part of business, as well as logistics-related issues, such as characteristics of transportation, modes of transportation and warehouse operations were discussed. As Metso does not operate transportation and a few warehouses have been outsourced, outsourcing functions were considered as well. Furthermore, since information technology forms a significant part of daily functions of companies, the theory section concentrated on the systems used in the order-to-delivery process.

An analysis of the current state of the order-to-delivery process for selected units of Metso Minerals has been carried out in this thesis. Their differences and similarities as well as problems and development targets of the processes were examined. Observation of working of the various actors involved in the order-to-delivery process combined with interviews of the personnel provided information about the current state and generated ideas for the development. It was noted during the study that Metso Minerals' order-to-delivery process is similar to that reported in the literature.

Automation and harmonization of the processes between Metso Minerals locations were identified as the major development initiatives based on the identified challenges, and they can be applied to nearly all of the stages of the order-to-delivery process. More detailed development targets included improving the quality of master data in SAP, the increased use of MTG when sending transportation orders to freight forwarders, and integration of P4T and MTG. In addition, DCs should have a shared order office to which the customers could contact regarding their orders. Furthermore, MTG could be developed in several ways. A significant suggestion was that the mode of transportation and service provider would not be defined in the ordering phase. Rather, MTG would make decisions based on pre-defined terms. Finally, the transportation pricing policy in the different units should be unified.

TIIVISTELMÄ

KATI POLLARI: Tilaus-toimitusprosessin kehittäminen kuljetusten näkökulmasta
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Tehokas tilaus-toimitusprosessi on tärkeä kilpailutekijä yrityksen toiminnalle. Tässä työssä keskityttiin kuljetuksiin liittyviin haasteisiin ja kehityskohteisiin Metso Mineralsin kuudessa yksikössä. Koska kuljetus on yhteydessä moniin tilaus-toimitusprosessin aliprosesseihin, lähes koko prosessi otettiin tutkimuksessa huomioon. Päätavoitteena oli selvittää, miten tilaus-toimitusprosessia voidaan kehittää selkeämmäksi ja kustannustehokkaammaksi siten, että Metso Minerals voisi tarjota asiakkailleen entistä parempaa palvelua ja laatua. Tämä työ toimii pohjana tuleville tilaus-toimitusprosessin kehitysprojekteille Metso Mineralsissa.

Teoriaosuudessa käsiteltiin tilaus-toimitusprosessia ja toimitusketjun hallintaa. Myös logistiikka liiketoiminnan tärkeänä osana sekä siihen liittyvät asiat, kuten kuljetusten ja kuljetusmuotojen ominaisuuksia sekä varastotoimintoja esiteltiin. Koska Metso ei suorita itse kuljetuksia ja osa varastoista on ulkoistettu, myös toimintojen ulkoistamista käsiteltiin. Tietotekniikka on suuressa osassa yritysten päivittäisiä toimintoja, joten teoriaosuus otti kantaa myös tilaus-toimitusprosessissa käytettäviin järjestelmiin.

Tässä diplomityössä tehtiin nykytila-analyysi Metso Mineralsin tähän työhön valittujen yksiköiden tilaus-toimitusprosesseista. Niiden eroja ja yhtäläisyyksiä pyrittiin löytämään sekä huomaamaan prosessien ongelmat ja kehityskohteet. Nykytilaa kartoitettiin sekä kehitysideoita löydettiin havainnoimalla tilaus-toimitusprosessin eri toimijoiden työskentelyä sekä haastattelemalla heitä. Tutkimuksessa huomattiin, että tilaus-toimitusprosessi Metso Mineralsissa on samankaltainen kuin kirjallisuudessa esitetty.

Tilaus-toimitusprosessissa havaittujen haasteiden perusteella tärkeimmät kehitettävät kokonaisuudet olivat Metso Mineralsin yksiköiden prosessien yhdenmukaistaminen ja automatisointi. Näitä voidaan soveltaa lähes jokaiseen tilaus-toimitusprosessin vaiheeseen. Yksityiskohtaisempia kehityskohteita olivat SAP:ssa olevan master datan laadun parantaminen, MTG:n käytön lisääminen lähetettäessä kuljetustilauksia huolitsijoille sekä P4T:n ja MTG:n integraatio. Lisäksi DC:illä tulisi olla yksi yhteinen tilaustoimisto, johon asiakkaat ottaisivat yhteyttä tilauksiin liittyvissä asioissa. Myös MTG:tä voitaisiin kehittää usealla tavalla. Yksi merkittävä ehdotus oli, että tilausvaiheessa ei päätettäisi kuljetusmuotoa ja palveluntarjoajaa, vaan päätöksenteko annettaisiin MTG:lle tarkasti määriteltyjen ehtojen mukaan. Lisäksi kuljetusten hinnoittelupolitiikka tulisi olla yhtenäinen eri yksiköiden kesken.

PREFACE

I wrote this master's thesis commissioned by Metso Corporation and Metso Minerals Inc. during the year 2016. Metso has a versatile supply chain because the company operates around the world and offers a wide range of products. In my work as a logistics coordinator, I noticed issues which could be developed further, so I wanted to explore the delivery process in more detail. Metso offered me an opportunity for it. This research period has been really interesting and a major learning process for me. I have learnt about processes and operating models of Metso. The topic of the thesis was interesting and wide. I hope the results of this thesis will be used the basis for order-to-delivery process development projects in the future.

I would like to thank my supervisors Mr. Teppo Siivonen and Mrs. Tuuli Arkimies, representatives of Metso, for the guidance and comments, as well as for support during the thesis process. Thank you for the opportunity to meet the interviewees face-to-face, and to visit at the warehouse to see processes on-site. Many thanks to the interviewees for the time and invaluable responses during the interviews. I would like to thank my colleagues for the advice and interest in my thesis.

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Tampere, 23rd of November 2016

Kati Pollari

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LIST OF TERMS AND ABBREVIATIONS

3PL	Third Party Logistics is a company which provide outsourced logistics services.
4PL	Fourth Party Logistics is an independent and accountable integrator of customers' supply and demand chains.
Breakpoint	Weight limit: if a shipment weighs more than a certain number of kilograms, it is shipped on one mode of transportation but if it weighs less, the mode of transportation is different.
CPT	Incoterms 2010: Carriage Paid to (named place of destination).
DAP	Incoterms 2010: Delivery at Place (named place of delivery).
DC	Distribution Center.
DCE	Distribution Center Europe, the part of Metso Minerals Inc. and its Service Business Area.
EA	Every Angle is a business analytics solution linked to SAP. For Metso Minerals Every Angle offers a report for monitoring orders.
EAI	Enterprise Application Integration is integration service enabling delivery of business data between applications.
EDI	Electronic Data Interchange is the exchange of business documents in a standard electronic format between computers.
ERP system	Enterprise Resource Planning system may integrate all departments and operations across a company. The systems are often combined with other IT technologies.
EXW	Incoterms 2010: Ex Works (named place).
FCA	Incoterms 2010: Free Carrier (named place of delivery).
FOC	Order type at Metso Minerals: Free of Charge. An order is shipped without charges.
Forwarder	A forwarder is a company which arrange storage and shipping services for shippers. Services may include, for example, tracking inland transportation, export documents, booking freight space and freight consolidation. In this thesis, the forwarder means a logistics service provider.
ICPO	Order type at Metso Minerals: Inter Company Purchase Order. An internal customer orders stock replenishment.
ICSO	Order type at Metso Minerals: Inter Company Sales Order. An internal customer places an order into SAP.
iDoc	SAP sends iDoc messages to EAI Service which converts them UBL Waybill format and sends forward to MTG. Messages are again in iDoc format when they return to SAP.
Incoterms 2010	Incoterms are a collection of the terms of a delivery. The International Chamber of Commerce manages them and in 2010 updated terms include 11 different incoterms. An incoterm defines responsibilities of a shipment between a seller and buyer.
IOD	Information of Delivery provided by a forwarder.
ISA	Internet Sales is a portal on extranet, where distributors can place orders for Metso Minerals.
KPI	Key Performance Indicator.
Manifest	A manifest is a transportation document which informs a summary of waybills for a certain voyage. The document lists details, such as a consignor, consignee, destination, and number.

MRE	Metal Recycling business line is the part of Minerals Capital Business Area of Metso.
MRS	Master Rate Sheets where freight costs are offered for Metso.
MTG	Metso Transportation Gateway is a transportation management system at Metso.
MTO	Make-to-Order.
MTS	Make-to-Stock or Manufacture to Stock.
Nomination	A forwarder whom has been nominated for certain business, like certain trade lanes.
OA	Order Acknowledgement is a sales order confirmation which is sent to a customer when the order is done and confirmed.
ODP	Order-to-Delivery Process.
ODR	Operational Discrepancy Report which is sent by warehouse personnel if they have some problems with orders.
P4T	Pool4Tool is a purchase order management system at Metso Minerals.
PO	Order type at Metso Minerals: Purchase Order. A customer service representative places a received order into SAP as a sales order.
POD	Proof of Delivery is a receipt signed by a consignee. It proves that a shipment is in good condition.
Prime	Prime is a tool for the global inventory planning team. The tool calculates inventory levels and makes requisitions. It enables better planning and inventory control in the distribution processes.
RFQ	Request for Quotations are used in requesting costs and delivery quotes which fulfill defined quality specifications for an exact quantity of specific goods or services.
SAP	SAP is a company which provides one of the Enterprise Resource Planning systems called SAP.
SCM	Supply Chain Management is the systemic and strategic coordination of business functions.
SLA	Service Level Agreement is the customer promise of the expected service level. Metso has internal service level agreed between operations and sales.
SO	Order type at Metso Minerals: Sales Order.
SSO	Sales and Service Office at Metso.
STO	Stock Transfer Order is inter-company movement of stock.
Supplier	In this thesis a supplier is a company which supplies goods for Metso Minerals.
TMS	Transportation Management System.
TO	Transfer Order in SAP contains information required to execute the physical transfer of materials into or out of the warehouse or from one storage bin to another within the warehouse. In practice, SAP user can see if an item is available for the order or if the item has been picked.
UBL Waybill	MTG receives UBL Waybill messages from EAI Service where SAP's iDoc messages have been converted.

1. INTRODUCTION

This master's thesis forms the basis for development projects of the order-to-delivery process in an industrial company Metso. Metso is a Finnish corporation which serves the mining, aggregates, recycling, oil, gas, pulp, paper and process industries globally (Metso 2015a). Metso has a strong market position in its own business sector: minerals and flow control business areas (Metso Oyj 2015, p. 11). Metso offers products, systems, projects and services business for customers. Deliveries depend on the industry. The mining industry uses project deliveries, whereas in aggregates and oil and gas industries individual equipment deliveries are common. (Metso 2016a.) Metso received orders worth 2,965 million euros in 2015 (Metso Oyj 2015, p. 5). Because Metso organizes several deliveries per day, it is important that the deliveries are as optimized as possible. More information about the company will be presented in Chapter 4.

This thesis will focus mainly on Metso's Services Business area, which consists of wear solutions, spare parts and performance services (Metso 2015a). Metso has global distribution centers (DC), which are a part of Metso´s Service Business Line. DCs handle wear and spare parts service for crushing and screening solutions. DCs have departments of customer service, product support, planning and procurement, logistics, warehouse operations and development.

This thesis deals with an order-to-delivery process (ODP) with emphasis on deliveries in the selected units of Metso. The order-to-delivery process is one of the key processes of organizations and it can be developed in many ways. The development of the process enables improving of the quality of operations and achieving savings. Several phases of the process have an impact on deliveries. Metso aims for constant improvement with deliveries: they should be better organized, more precise, more cost-efficient, and more optimized than previous deliveries. One of the goals of this thesis is to investigate whether it would be beneficial to improve the order-to-delivery process by automating selection of transportation modes and forwarders. A forwarder is a company which arranges storage and shipping services, such as tracking inland transportation, export documents, booking freight space and freight consolidation, for shippers (BusinessDictionary 2016a). A system could select a correct mode of transportation and, based on the mode of transportation, the forwarder as well. Thus deliveries might be more correct and quantity of errors might decrease.

An order-to-delivery process is one of the key processes in business. The process contains several phases which all could be developed. The process is a chain, which starts when a customer has a need for a product, and ends when the customer has paid the received

order. The main steps of the ODP are placing the order, purchasing goods, manufacturing goods and shipping the goods to the customer.

An order-to-delivery process is managed by the supply chain organization. A supply chain will be defined in Section 3.1. Logistics as the part of the supply chain enables global business. Logistics is a competitive factor that may lead to better customer satisfaction, inventory turn, lead times as well as big savings in companies. Because Metso provides various parts for customers' core business processes, standard deliveries are not always possible. Features, weight, dimensions, shape and quantity of material of orders may vary significantly. One order may contain one or 200 parts and it may weigh 100 grams or 20 000 kilograms.

Metso ships orders by optimizing the road, courier, air and ocean third party logistics (3PL) companies, which provide logistics services (Power et al. 2007, p. 228) around the world. Courier service is often international express delivery service, which specializes in the transportation of small parcels and letters (Karrus 1998, p. 307). There is domestic transportation, transportation within a certain region such as the European Union (EU), and transportation between continents. Metso aims to improve customer satisfaction by offering better lead times and quality with less costs. The target is ambitious, especially since there are numerous special and urgent orders, but Metso believes that it can be reached with prime system support.

The next chapter 1.1 will introduce the background and purpose of this research. The objectives, scope, research problem and research questions are presented in Sections 1.2, 1.3 and 1.4. Finally, the structure of the thesis will be discussed in Section 1.5.

1.1 Background, Focus and Purpose of the Research

It is essential for modern companies to be customer-oriented and also to work cost-effectively. Because of the present situation of world economy, it is necessary to develop processes leading to increased competitiveness and efficiency. Companies need to be able to operate more cost-effectively and more productively than previously. Often when a company wants to develop its business, one significant development target is an order-to-delivery process because it contains many operations of a company. Orders form the basis for a company's operations, while deliveries are the final step – and the only step of the process that is concretely visible to the customer. Because the process includes a plurality of stages, it can be improved in various ways. This thesis deals mainly with transportation decisions, which are one part of the process. Four important indicators in the supply chain to ensure customer satisfaction and to enhance business benefits are time, quality, reliability and costs of the delivery.

An order-to-delivery process refers to a process, which starts when a customer has a need for goods and ends when the company has delivered the goods to the customer (Forslund

et al. 2008, p. 43). According to Larson & Gammelgaard (2001, cited in Forslund et al. 2008, p. 42) the order-to-delivery process requires a minimum three actors: a customer, supplier, and logistics service provider. In this thesis a supplier is defined so that it is a company which supplies goods for Metso.

Modern systems are well developed which means that manual routine procedures have been reduced. Automation is both viable and prevalent: a machine can make all the decisions based on pre-given conditions. Metso has an own transportation management system Metso Transportation Gateway (MTG) which is being developed based on the business needs and there will be modified functions based on the changed business needs. Manual work increasingly moves from people to systems, with the result that human resources can be concentrated in follow-up and customer service. In addition, automation reduces human errors in the handling of orders.

Because of the current global economic situation, the current popular trend is to invest in spare parts rather than machines. Industrial companies do not want to make investments in a large scale but prefer to repair and optimize present machinery. According to Metso Oyj (2015, p. 2), the year 2015 was satisfactory for Metso despite the decrease in China's economic growth, which has led to a decline in mineral prices. This means decreased amount of investments. Some mines have even had to be closed. These factors have affected services business, which has performed well despite the current market situation. (Metso Oyj 2015, p. 2.)

The research will be challenging and broad because the order-to-delivery process of Metso is versatile and does not follow a specific formula. Units operate in different ways and there are various ways to order material and to receive orders. The types of deliveries vary, because the parts offered by Metso differ in size and shape. Spare part deliveries may be urgent if a machine is for example broken. In such situations, the order handling, processing and the delivery time should be as short as possible. For the deliveries around the world, Metso uses outsourced logistics services and service partners, forwarders, and carriers as Third Party Logistics (3PL) providers. Metso organizes deliveries and by choosing the suitable transportation mode and forwarder carefully, Metso can reduce transportation costs and ensure a sensible delivery of the order.

This master's thesis is essential for the target company's business. Metso Minerals arranges several deliveries per day. If all transportations can be arranged as properly as possible, greater savings, better service and quality can be achieved. Orders can be placed by Metso Minerals' customer service representative (order desk or order entry team), or by the customer. The transportation mode and, at times, forwarder are selected when the order is being made. The person who places the order may not be a logistics professional, and the possible lack of expertise may result in inadequate choice of a delivery method for the goods. By choosing the most optimal way to deliver the order, the corporation can be more cost-effective and improve quality as well as customer service.

One of the goals of this research is the automatic selection of transportation modes and forwarders. The idea for automation has arisen at Metso before this thesis. If all possible transportation options were entered into systems, the system could choose the optimal delivery option for each shipment by using the defined conditions. Owing to the advanced information systems, the optimization of deliveries is easier than in the past.

In this research, the present state of order-to-delivery process will be investigated, and special attention will be given for the choice of transportation decisions for Metso Minerals' products. Other issues related to transportation will also be taken into account. Furthermore, the paper will investigate how the process could be enhanced. The aim is to improve the cost-effectiveness, quality, delivery reliability, and delivery times of the order-to-delivery process. In addition, by organizing deliveries as required by the order (delivery priority, size of shipment, distance between a warehouse and a customer), the company can use more ecological transportation modes for deliveries. As an example, Metso could deliver the goods by road transportation instead of air transportation, if customer needs are better known as well as managed. This would reduce an amount of urgent deliveries and offer more opportunities to consolidate shipments. This would benefit both the company and customers because the deliveries could be arranged more cost-effectively. Customer service and quality would be better as well.

1.2 Objectives

The aim of this thesis is to discover the current state of the order-to-delivery process at the industrial and service company Metso Minerals, and suggest ways to improve it. The main goal is to find a transportation optimization solution to improve the order-to-delivery process at Metso. The target is to improve quality and service level, and to lower the costs. In addition to transportation decisions, the whole order-to-delivery process will be examined. First, the order-to-delivery process will be investigated, and the pros and cons will be discussed. Second, the ideas for development will be suggested, including suggestions for a more efficient process to choose the forwarder and the mode of transportation. The ideal process will be based on interviews, and data and observation which support the interviews as well as on literature. Solutions will be found by answering to the research question and sub research questions, which will be presented in Chapter 1.4.

The theoretical part of this study concerns the most important topics related to a supply chain management, like an order-to-delivery process, transportation, warehouse operations, and systems to increase an understanding of the topic. In the empirical part, the aim is to explore the order-to-delivery process in the target company, based on the research problem and questions. The research aims to chart the present state and functionality of Metso Minerals' order-to-delivery process. This will be done by describing the process and by interviewing several actors. It will be seeked to find what are the main problems in the current way of operate. By examining these problems and comparing the present state with theory and solution proposals obtained from interviews, development targets

will be found. On the basis of these findings, there will be looked for a realistic way of working in the future. The aim is to make the order-to-delivery process more efficient than until today. This way the company can achieve also financial savings.

1.3 Scope

The order-to-delivery process is handled from starting when a customer has a need for a product and ending when the customer has paid the received order. All the functions in the ODP share the same values including the driving customer success, what is also the key value in this research. This thesis will cover:

- Distribution Center Europe (DCE), Finland,
- Distribution Center Trelleborg, Sweden,
- Metal Recycling (MRE) Düsseldorf, Germany,
- Distribution Center/Sales and Service Office (SSO) Mâcon, France,
- Sales and Service Office Rugby, the United Kingdom and
- Domestic Sales, Finland.

The suggested solutions to the research problem and questions are wanted to launch in other locations of Metso Minerals also. It was not possible to include all of Metso locations in this thesis due to size of the company. These six units were chosen for the thesis because of the differences in their order-to-delivery processes. The differences and challenges of an individual location may help to discover a workable process for every unit. For example, there are different functionalities in SAP, such as that a shipment creation can be either automatic or manual. SAP is a company which provides one of the enterprise resource planning systems called SAP. The aim is to unify the order-to-delivery process at Metso Minerals. If the initial analysis focused only on the DCE's process and its challenges, it would not be possible to take all challenges of the company into consideration, because other units may be experiencing different problems. Then the process in each location could not be improved in the same way. If the process of a certain location is similar to the process at DCE, interviews there are not necessary. New practices of the process could be customized to all units.

An order-to-delivery process will be investigated from the perspective of logistics. In this research, both inbound and outbound logistics will be taken into account. Inbound means mainly materials which purchasers order to Metso warehouses, whereas outbound means the goods which are shipped from the warehouses to customers. The order-to-delivery process will be examined from the moment the order is placed to the point when it is delivered to the customer. For the most part, the order-to-delivery process is examined in the initial stages of the process, when the information is placed into SAP, and essential details for the transportation are selected. Determining factors include, for example, the urgency of the order, the delivery place and size of the part. The order-to-delivery process

will be handled generally, and literature review will not discuss the challenges of the process.

Incoterms are a collection of the terms of a delivery. The International Chamber of Commerce manages them and in 2010 updated terms includes 11 different incoterms. An incoterm defines responsibilities of a shipment between a seller and buyer. (Logistiikan maailma 2016a.) Incoterms of deliveries do not influence the process directly, whereas the payer of the freight does affect it. If the customer is Metso Minerals' distributor who pays the freight, the customer decides the mode of transportation and the forwarder, so these order types are out of scope in this thesis.

If one of Metso Minerals' business units sells material to Metso Minerals' another business unit, and the latter sells material to the end customer, there are no common rules how freight cost is charged. These situations will be examined in the interviews. Also this will be harmonized between different locations based on the results in this thesis.

Several people related to the order-to-delivery process, or systems in selected units of Metso Minerals, will be interviewed in this research. The systems are enterprise resource planning (ERP) system, which may integrate departments and operations across a company (Somers & Nelson 2001, p. 1) and transportation management system (Helo & Szekely 2005, p. 8) (TMS). ERP systems are often combined with other IT technologies (Botta-Genoulaz et al. 2005, p. 517). Because this thesis focuses on an internal order-to-delivery process, customers, with the exception of other units of Metso, or forwarders will not be interviewed. The aim is to improve customer service but customers are not aware of the internal processes. They could affect only targets of the process, not the way to improve the process. This thesis does not take a stand on which freight forwarders are used.

Metso has nominated forwarders from each departure address to each destination. This work will not have an impact on nominations. A nomination refers to a forwarder who is responsible for Metso's deliveries from a country to another by using an exact mode of transportation. The nomination may vary between lanes. The nominations are decided during Request for Quotation (RFQ) process. RFQ is used in requesting costs and lead times which fulfills the defined quality specifications for an exact quantity of specific goods or services (BusinessDictionary 2016b). In the order-to-delivery process, nominated forwarders will be used and the goal is to focus on the efficient modes of transportation.

1.4 Research Problem and Research Questions

The research problem of this thesis is to examine what the term order-to-delivery process means, how it is perceived at Metso Minerals, and how it could be developed further. In

order for Metso to be able to invest in correct development targets, careful investigation of the current status of the order-to-delivery process is vital.

The main research question is the following:

- **How the order-to-delivery process could be developed more cost-effective in order to improve the quality?**

The sub research questions are:

- **What is an order-to-delivery process?**
- **What is the current state of the order-to-delivery process at Metso Minerals?**
- **How the mode of transportation and the forwarder are currently selected?**
- **What kind of problems there are in the present order-to-delivery process?**
- **How the order-to-delivery process could be further developed?**

The sub research questions focus the main research question. The first sub research question is necessary to define the key term of the thesis, while the rest aim to describe the process at Metso Minerals by comparing it to theory. By answering to the research questions is aimed to find ways how to achieve customer satisfaction and savings by delivering orders accurately and cost-effectively.

1.5 Structure

The research methods will be introduced in Chapter 2. The theoretical approach will be presented in Chapter 3. The main subject is a supply chain management containing an order-to-delivery process, transportation, outsourcing, packing and IT systems. The empirical part of the thesis will be covered in Chapters 4, 5 and 6. Chapter 4 will discuss Metso as a company and order-to-delivery processes in selected units of Metso. The process description will be based on observations and interviews. In Chapter 5, the pros and cons of the current process will be evaluated on the basis of the interviews. Chapter 6 focuses on the development ideas for the order-to-delivery process of Metso Minerals. These improvements may be expanded to other locations as well.

Chapter 7 will analyze the results of the thesis and the conclusion is in Chapter 8. After that the references will be collected together and in the end of the thesis will be an appendix including the interview questions.

2. RESEARCH METHODS

This chapter focuses on research methods and presents which methods will be used in this thesis. The chapter discusses the choices of the philosophy of science and presents the selected research methods.

Literature research and interview survey are the main research methods in this thesis. Observation and analysis of data form a smaller part of the thesis. Theoretical and empirical sections will be compared in the results.

2.1 Philosophy of Science, Research Approach and Research Methods

The choice of a research strategy is affected by the type and goals of the research and what kind of philosophy of science is wanted to follow. Studies in management help to understand and enhance the performance of a business (Gummesson 2000, p. 5). A research is important because new information can be found which would not possible on the basis of everyday thinking. With the new information, problems can be solved better. The type of research intended to reach a practical goal is called an applied research. (Hirsjärvi et al. 2007, p. 19.)

In order to choose the suitable research method, researchers need to discover how studies are classified. In the traditional study, the division is performed between the hermeneutic and positivistic research (Gummesson 2000, s. 19). According to Olkkonen (1994, p. 50), in positivism the data has to be based on established and verifiable matters. The research must be repeatable and independent of researchers (Olkkonen 1994, p. 35). Generalizability, predictability and causal explanations are all related to positivist research approach (Hirsjärvi & Hurme 2008, p. 22). According to Glesne & Peshkin (1992, cited in Hirsjärvi & Hurme 2008, p. 22), quantitative research aims to generalizability, predictability and causal explanations, whereas qualitative research strives for contextuality, interpretation and understanding of perspective of actors. The model of qualitative research is from hermeneutic research approach (Hirsjärvi & Hurme 2008, p. 22). In hermeneutic approach, the research aims to understand the internal connections and change processes of the phenomenon (Olkkonen 1994, p. 33). Olkkonen (1994, p. 52) argues that case study is based on the hermeneutic research approach.

Deductive analysis is a theory-driven analysis method used traditionally in scientific studies (Tuomi & Sarajärvi 2002, p. 95–99, cited in Saaranen-Kauppinen & Puusniekka 2006a). Quantitative research approach is based on a deductive process which proceed from general to detailed. It aims to find causality, and to predict, explain, and understand the phenomenon. (Hirsjärvi & Hurme 2008, p. 25.) In comparison, qualitative research is

based on an inductive process, from detailed to general. It is context-embedded and theories and patterns are developed during the research. (Creswell 2014, p. 65, 186.) However, a clear inductive inference is not possible (Tuomi & Sarajärvi 2002, p. 98, cited in Saaranen-Kauppinen & Puusniekka 2006a). This thesis aims to find the pros and cons of Metso Minerals' current order-to-delivery process, and suggest ways to develop the process. The aim is to increase understanding of the subject which means that the research is both hermeneutic and inductive.

A research strategy refers to all the methodological solutions which are used in a research. It should be noted that the term is not equal to a research method. The selection of the strategy and methods depend on the research problem. (Hirsjärvi et al. 2007, p. 128.) There are several research strategies. According to Hirsjärvi et al. (2007, p. 130–131), there are three main traditional research strategies: experimental, survey and case strategy. In the experimental study, the influence of one treated variable to another is measured. In the survey study, the data is collected from a crowd of people in a standardized format. The third strategy, case study, deals with detailed information about an individual case or a small number of cases. (Hirsjärvi et al. 2007, p. 130–131.)

"How" and "why" questions are the main research questions in a case study. The case study focuses on contemporary events. (Yin 2014, p. 9.) Different strategies are designed to meet different types of research questions. Yin (2014, p. 11) considers it important that the research method can be selected depending on the research questions. Different research methods are, for example, an experiment, survey, archival analysis, history and case study (Yin 2014, p. 9). The main types of research are an experimental study, case study, discourse analysis, conversation analysis, ethnography, grounded theory, phenomenography, biography research, operational research and history research (Hirsjärvi et al. 2007, p. 186–187). The main types of research suitable for qualitative or quantitative research are presented in Table 2.1.1.

Table 2.1.1. *Basic types of a research and using of them in a qualitative or quantitative research (Hirsjärvi et al. 2007, p. 186–187; Jyväskylän yliopisto 2015a).*

Research types	**Qualitative research**	**Quantitative research**
Experimental study		x
Survey study	x	x (mainly)
Case study	x	x
Discourse analysis	x	
Conversation analysis	x	
Ethnography	x	
Grounded theory	x	
Phenomenography	x	
Biography research	x	

Operational research	x	
History research	x (mainly)	x

It is possible to examine the investigate phenomenon either in short or long term. Hirsjärvi et al. (2007, p. 173) argue that longitudinal study is useful if the aim is to follow the development of a certain phenomenon, or discover how processing influences matters. Cross-sectional study instead enables an implementation of the survey in a short time (Hirsjärvi et al. 2007, p. 173). This research is cross-sectional, because the order-to-delivery process is investigated in its present situation.

While doing a research, it is important to make the distinction between qualitative and quantitative approach. Both approaches can be used in case studies to collect data (Gummesson 2000, p. 3). According to Hirsjärvi et al. (2007, p. 132), qualitative and quantitative approach may also complement each other. Characteristics of a quantitative research are that conclusions of previous studies and theories exist, hypotheses are presented and concepts are defined. In addition, the observation data needs to be suitable for the quantitative and numerical measuring. The population is defined and the subjects must be chosen accurately. The results must be valid in the population so that a sample can be selected from the population. In a quantitative research, the data has to be in a statistically processed form. Conclusions are based on statistical analysis of the observation data. The results are described, inter alia, as a percentage. (Hirsjärvi et al. 2007, p. 136.) The qualitative research aims to describe the actual situation and the object is investigated as comprehensively as possible. Typical features of a qualitative research are that the research process is a comprehensive acquisition of knowledge and data is collected from actual situations. The researcher collects data directly from people. The data is collected with methods such as a theme interview, participant observation, group interview, or analysis of various documents and texts. The target group is selected appropriately, not using a random sample method. It is important to note that the research plan forms as the study progresses. Plans may have to be changed in accordance with the conditions. Cases are dealt with as a unique and the content is interpreted accordingly. (Hirsjärvi et al. 2007, p. 157, 160.)

The research types have their unique features but there are also common elements. For example, the same data collection methods are used. The basic methods of data collection are an inquiry, interview, observation and documents. (Hirsjärvi et al. 2007, p. 186–187.) An interview is a basic method of acquiring data (Hirsjärvi & Hurme 2008, p. 11). Interviews can be used as a form of data collection tool in a qualitative research: open questions or selected discussion topics are presented to individuals or groups. In qualitative research, interviewees are often selected in advance, and open question interview or theme interview are the basic forms of interviews used. The interpretation covers the entire research process. In comparison, typical characteristics of quantitative research include interviews based on a random sample, and truthfulness of the material is essential.

There are certain critical points in the study process, after which it is not possible to return to the previous stages. A quantitative research invariably contains a numerical observation matrix in which the data is summarized. (Tilastokeskus 2016.) Based on the information obtained from the theory, this research will be carried out using qualitative research.

Material collected during a theme interview is often diverse. Analysis of the material should be initiated immediately after the collection phase when in it is easier to supplement the collected information. Individual results should be viewed from a wide perspective and as a whole. (Hirsjärvi & Hurme 2008, p. 135.) For this research, a large number of people were interviewed which means that there is an abundance of material. All of the material does not need to be analyzed: the researcher cannot make use of all gathered material in all cases (Hirsjärvi & Hurme 2008, p. 135). The classic role of a research is the role of analyst (Gummesson 2000, p. 38). Hirsjärvi & Hurme (2008, p. 136) argue that analysis starts already during interviews. Qualitative analysis methods are counting, scaling, thematizing, analysis of connections, analysis of progression and the use of metaphors (Hirsjärvi & Hurme 2008, p. 171–174, 176, 179). Counting, thematizing and analysis of connections are used in this thesis. Counting is simple and refers to the number of times a certain phenomenon occurs in the data (Hirsjärvi & Hurme 2008, p. 172). In this thesis, the main results are the issues which were raised often in the interviews. It is not possible to make exact calculations of the results because all questions were not asked from all the interviewees. According to Hirsjärvi & Hurme (2008, p. 173), thematizing means that in the analysis phase the researcher searches the data for features which appear in the answers of several interviewees. In addition to the original theme, other themes are often visible in the results. A review of factors raised up from data of the interviews in relation to each other is perhaps the most essential part of the analysis. (Hirsjärvi & Hurme 2008, p. 173–174.) The results will be divided into themes which then will be combined.

The researcher can use inductive or abductive inference. Inductive inference is material oriented, whereas in abductive inference the researcher has prepared theoretical ideas which the researcher strives to prove using collected material. (Hirsjärvi & Hurme 2008, p. 136.) The interview conducted within this research, uses both of those inferences. The majority of the questions are analyzed on the basis of the material but there is also a hypothesis. It is wanted to check if interviewees consider a scenario as a positive or negative idea. There may be pre-thoughts or a hypothesis related to a subject of qualitative research but those might change by field experience (Kiviniemi, in Valli & Aaltola (eds.) 2015a, p. 75). The interviews in this thesis are not transcribed. Another way to decode interview material is to make conclusions directly from the recorded material (Hirsjärvi & Hurme 2008, p. 138) as done in this thesis. The researcher tries to find connections in material.

In a certain respect, all qualitative researches are case study researches, because a particular case is examined on each time. In case study research, the case forms an entity. An individual event and a limited entity is investigated by using variety methods and obtained data. The case study aims to explore, describe, and explain the cases mainly by asking "how" and "why". A case study can use both quantitative and qualitative methods. Often a case study is related to an organization: the study can be a project, development study, or evaluation study. It is not always possible to generalize the results. (Saaranen-Kauppinen & Puusniekka 2006b.) A case study is a suitable choice for this thesis because the research investigates an individual process from multiple perspectives. The process is its own entity and it is not shared by other companies. However, the generalized characteristics are likely to find. Table 2.1.2. presents the methodology used in this thesis.

Table 2.1.2. *Methodology of this thesis.*

Philosophy	Hermeneutic
Approach	Inductive
Strategy	Case study
Time horizon	Cross-sectional
Type of research	Qualitative (mainly)
Data collection method	Interviews (complement: observation and analysis of data)
Data analysis	Counting, thematizing and analysis of connections

This research is divided into a literature review and interview survey, which are presented in more detail below. In addition, the process description is based on the observation.

2.2 Literature Research

The theoretical part of the study will be executed as a literature research. Thus, it is possible to identify the information that is available about the subject.

Literature is used to support the research. The length of the literature review may vary depending on the audience. (Yin 2014, p. 192.) In this thesis, the main focus is on empirical research: the aim is to concentrate on Metso Minerals' order-to-delivery process. Literature research presents theory related to the subject of the research but does not attempt to explore new issues. A literature review is a theoretical or conceptual framework which focuses on the relevant literature in terms of the research (Hirsjärvi et al. 2007, p. 117). While conducting the literature review, the researcher should constantly bear in mind the objectives and the research question. It is important to consider why the certain information has been selected to be used in the study. Previous research data must be treated

critically. When referring to the sources, the researcher must be careful, honest and objective. The aim is to discuss with previous researches on the basis of the own target and the research problem. (Hirsjärvi et al. 2007, p. 253–254.)

In the literature review both Finnish and foreign texts, such as books, articles, web pages, and research papers, have been used. Tampere University of Technology databases have been utilized as well. There are also several good scientific online journals, such as Elsevier and Emerald. Google Scholar is one of the most exploited web search engines. The major keywords were an order-to-delivery process, supply chain management, transportation, mode of transportation, and warehouse operations. The articles were selected from the search results based on their titles and abstracts.

The study aims to use contemporary material whenever possible. Certain aspects have remained unchanged for several decades so older material is used as well where appropriate. The intent has been to find similarities in the material.

2.3 Interview Survey

Interview is a unique data collection method because of the straight verbal communication between a researcher and an interviewee. Interview research has both advantages and disadvantages. The most important advantage is its flexibility. (Hirsjärvi et al. 2007, p. 199; Hirsjärvi & Hurme 2008, p. 11.) An interview is also typically perceived as comfortable (Hirsjärvi & Hurme 2008, p. 11). Interview research may be chosen as a method due to following facts. For example, the researcher should see the participants as subjects, and, if the area of investigation is little-charted, it is challenging for the researcher to foretell the trends of the results. The interviewee's facial expressions and gestures bring additional value to the results. If the subject of the research produces multifaceted answers, an interview is an appropriate way to collect data. An interview can be useful when the researcher wants to clarify or deepen the received information. For example, the researcher can request arguments for the answers. In addition, interviews can be used to investigate sensitive matters. (Hirsjärvi et al. 2007, p. 200–201.) An interview enables the researcher to focus directly on case study topics. A strength of an interview is that it is insightful. It helps to have expressions and personal views. (Yin 2014, p. 106.)

The negative sides of an interview are its time-consuming nature and the need for careful planning. In addition, the personalities of the participants may affect the results. (Hirsjärvi et al. 2007, p. 201.) One of the weaknesses is reflexivity: interviewers can hear what they expect to hear. Also, there may be bias for different reasons. In addition, inaccuracies are potential. (Yin 2014, p. 106.) If the aim of the research is to produce information related to opinions, perceptions, observations, attitudes, values or experiences, interviews are a valid method for collecting research data (Jyväskylän yliopisto 2015b). An interview is context-bound, which means that results are included in the interpretation (Hirsjärvi & Hurme 2008, p. 12).

There are several ways to interview people. According to Jyväskylän yliopisto (2015b) an interview can be, for example, unstructured such as an open interview, semi-structured, or structured interview also known as a form interview. In comparison, Hirsjärvi & Hurme (2008, p. 44–47) mention form interview, unstructured interview, and theme interview or semi-structured interview as types of research interview. An open interview is similar to a conversation between the researcher and interviewee (Jyväskylän yliopisto 2015b). An open interview is time-consuming and requires several interviews. According to Hirsjärvi et al. (2007, p. 203), a structured or form interview uses forms as a tool. The form and the order of questions and arguments are prescribed. Once the questions have been prepared, the structured interview is relatively straightforward. (Hirsjärvi et al. 2007, p. 203.) Forming of the questions is the greatest challenge in a structured interview (Hirsjärvi & Hurme 2008, p. 45). A theme interview is an intermediate form between a structured and unstructured interview. Often the theme of an interview is given but the exact form and order of the questions are incomplete. The theme interview can be used for both qualitative and quantitative research. (Hirsjärvi et al. 2007, p. 203.)

A theme interview is used as a data collection method in the empirical section of this thesis. It is an intermediate form between an open interview and a questionnaire survey. At times, an aspect of the interview has been decided in the semi-structured methods (Hirsjärvi & Hurme 2008, p. 47). The interviewer can ask questions in any order, and formulate new questions when the interview progresses. The participants discuss the given theme, but interviewer does not cover all the theme areas with all interviewees (Eskola & Vastamäki, in Valli & Aaltola (eds.) 2015b, p. 29). The subject of interviews in this thesis remains the same, but the actual interview questions depend on the interviewee. The questions will be presented from a different point of view because the interviewees' positions differ from each other.

There is no specific frame for an interview (Hirsjärvi et al. 2007, p. 204). The interview format can be, for example, an individual interview, pair interview, group interview, or interview with an expert (Hirsjärvi et al. 2007, p. 205; Jyväskylän yliopisto 2015b). Hirsjärvi & Hurme (2008, p. 61, 64) divide the ways to implement interviews in practice in three parts: an individual, group and phone interview. The most common way is to arrange individual interviews. Group interviews are a useful method as well, and their amount has increased. In a group interview, the researcher talks to several interviewees at the same time and can target questions to the group or to an individual participant. Group interview can be conducted as conversations. They can be useful if the researcher wants to discover how people form common opinions about given themes. (Hirsjärvi & Hurme 2008, p. 61.) The advantage of group interview is that it enables the researcher to obtain information faster, simultaneously from several respondents; the disadvantage may be autocratic members of the group (Hirsjärvi et al. 2007, p. 205; Hirsjärvi & Hurme 2008, p. 63). Quieter people might not get their voices heard. Phone interviews are normally structured and related to survey research (Hirsjärvi & Hurme 2008, p. 64).

Kvale (2007, p. 44) suggests that 15+/-10 people is a general amount of interviewees. The amount is a mix of the time and resources (Kvale 2007, p. 44). However, it should be noted that the number of interviewees has been correct when the necessary information has been received (Hirsjärvi & Hurme 2008, p. 58). There are several ways to save an interview. Interviews can be recorded, videotaped, or the researcher can fill out the form or make notes. (Jyväskylän yliopisto 2015b.) In this thesis, the researcher interviewed 22 people and used a sound recording device making notes at the same time. The recordings were essential that the interviewees and their answers were able to be connected afterwards.

The object of the case study is analyzed with the help of both individual and group interviews – in other words, the case study is a qualitative research. A group interview is a practical way to collect data for this research because the interviewees can supplement each other's answers. This means that ideas may receive more emphasis and lead the discussion onward.

The interview in this thesis contains three elements: the background, the current order-to-delivery process and ideas for development, and quality assurance. First, the interviewer introduced herself and her background. The subject and objectives of the thesis were presented as well. Next, the target of the interview was handled as well as how long the interview takes and if the interview can be recorded. Also interviewees introduced themselves. For some of the questions the interviewees were replied already by email. The main part, the target for the interview was to solve a current status of the order-to-delivery process, its advantages and disadvantages, and how the process could be developed. At the end of the interview, the interviewer wanted to make quality assurance and ask if the interviewees had still something to comment or ask. In the first and last part, which were background and quality assurance, questions were similar for everyone. In the middle stage, the exact questions depended on the interviewee but the themes were the same in all of the interviews. As the interviewees represent the different stages of the process and act in various tasks, the frame of the interview was modified to suit each interview. A few of the questions were used in all interviews. Interviews were held in Finnish for Finns and in English for non-Finns. The frame of the interview will be presented in Appendix 1.

The interviewees were selected so that all steps in Metso's internal order-to-delivery process would be taken into consideration. The interviewees had perspectives to purchase, sales, order entries, warehouse operations, logistics matters and systems. Persons were currently working at Metso. In this way a current state of the process, its challenges and development ideas were risen widely up. Each of the interviewees had a vision of the functioning of transportation at the moment, as well as suggestions for its improvement. A few of the interviews were group interviews, where all perspectives came up at the same time, and other participants had the chance to add their own comments. In order to obtain a sufficiently comprehensive sample, 22 experts from several Metso locations were

interviewed. The interviewees are presented in Table 2.3.1. If two or more lines in sequentially have the same color (green or white), it means that the interviewees were interviewed together.

Table 2.3.1. *Information of the interviewees.*

Role in Organization	**Business Line**	**Location of Interviewee / Type on Interview**
Process and Development Support Specialist	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, individual
Specialist, Process and System Development	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, individual
Customer Service Representative, Sales	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, group
Senior Customer Service Representative, Sales	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, group
Logistics Coordinator	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, group
Specialist, Logistics Development	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, group
Purchasing Engineer	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, individual
Sales Engineer	Market Area Nordics, Market Areas	Tampere, FI (Domestic Sales) / face-to-face, individual
Manager, Warehouse & Transportation Development	Global Supply Chain, Minerals Services	Tampere, FI / face-to-face, group
Logistics Manager	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, group
MTG System Manager	Global Supply Chain, Minerals Capital	Vantaa, FI / face-to-face, group
Warehouse Manager	Global Supply Chain, Minerals Services	Tampere, FI (DC) / face-to-face, individual
Logistics Coordinator	Recycling, Minerals Capital	Düsseldorf, DE / face-to-face, individual
DC Düsseldorf Manager	Recycling, Minerals Capital	Düsseldorf, DE / face-to-face, individual

Regional Director Distribution & Logistics	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Customer Service Manager, Sales	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Customer Service, Sales & SAP key user	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Procurement Manager	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Logistics & Warehouse Manager	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Team Lead Logistics	Global Supply Chain, Minerals Services	Trelleborg, SE (DC) / face-to-face, individual
Internal Sales & Product Support, Sales	Market Area Europe, Market Areas	Rugby, UK / Skype, individual
Process Development Services	Global Supply Chain, Minerals Services	Mâcon, FR / Skype, individual

Interviews were executed mainly face-to-face in the office where an interviewee works, but two interviews were organized via Skype. The interviews were held between May 6th to June 13th, 2016. Notes about the main points were made during the interviews but the interviews were also recorded to support the notes in further analysis. The interviews lasted 1–2 hours.

A semi-structured interview was used because it allowed deviations from the planned layouts for the interviews. Thus, it was possible to obtain more accurate information on issues which were not included in the interview and might not have otherwise arisen.

2.4 Observation of the Researcher and Analysis of Data

Research methods complement each other. Hirsjärvi & Hurme (2008, p. 38) argue that by using methods extensively it is possible to get broader perspectives and increase reliability of the research. Researchers should be flexible and select methods which are suitable for solving the investigated problem (Hirsjärvi & Hurme 2008, p. 39). Also Grönfors (in Valli & Aaltola (eds.) 2015b, p. 146) agrees that data from interviews can be combined successfully with data collected by other methods.

Metso has obtained plenty of data concerning the deliveries. Metso collects data mainly from ERP, transportation management system, service providers and invoicing system. The data is used as background information for the thesis. Because the thesis contains several interviews, the analysis of existing data serves mostly to support the interviews. The data is collected partly from reports and partly from Metso's Intranet.

In addition to data analysis, the process was observed to have a comprehensive picture of the whole order-to-delivery process. The process description is based on the observation, as well as questions made during the observation, and more detailed questions made during the interviews.

3. SUPPLY CHAIN MANAGEMENT

This chapter focuses on general issues concerning the supply chain management and an order-to-delivery process. The chapter will discuss with features of transportation and warehouse operations. In addition, information technology systems required in the order-to-delivery process will be handled.

According to Mentzer et al. (2001, p. 2), modern companies and especially supply chains compete in time and quality. A fast and reliable delivery has become a requirement instead of a competitive advantage. Customers want to receive products on time and without defects. This requires coordination with stakeholders such as suppliers and distributors, as well as flexibility from companies. (Mentzer et al. 2001, p. 2.)

3.1 Supply Chain and Supply Chain Management

The strength of a company's supply chain is one of the dominant factors for the success of the company (Cheng et al. 2008, p. 466). Supply chain consists of three parts: material flow, information flow and cash flow (Karrus 1998, p. 214) and four categories, which are supply, manufacturing, distribution and customer (Beamon 1999, cited in Cheng et al. 2008, p. 467). Four definitions of supply chain are presented below.

"*The supply chain is not just a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple businesses and relationships*" (Lambert et al. 1998, p. 1).

"Supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer" (Mentzer et al. 2001, p. 3).

"A supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers" (Beamon 1998, p. 2).

"A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm." (Ganeshan & Harrison 2002, p. 1.)

The same theme is repeated in all of the definitions. A supply chain is a network of businesses and relationships, where different parties work together so that acquired raw materials can be processed into products and delivered to customers. A supply chain contains product, service, finance and information flows from a source to a customer. It is unique in different organizations.

Basically, material flow is forward and information flow backward in a supply chain (Beamon 1998, p. 2). Companies pay attention to supply chains because they may increase competitiveness and reduce costs. A supply chain can be optimized by effective modes of operation. (Childerhouse & Towill 2003, p. 17.) Figure 3.1.1. shows one type of structure of a supply chain.

Figure 3.1.1. *A structure of a supply chain (adapted from Helo & Szekely 2005, p. 6).*

Mentzer et al. (2001, p. 5) describe both direct and ultimate supply chain as presented below in Figures 3.1.2. and 3.1.3. There is also an extended supply chain between these two models.

Figure 3.1.2. *A direct supply chain (adapted from Mentzer et al. 2001, p. 5).*

A direct supply chain is the simplest form of a supply chain. It includes an organization, supplier and customer, who are involved in the upstream or downstream. The flow may be of products, services, cash or information. (Mentzer et al. 2001, p. 4.)

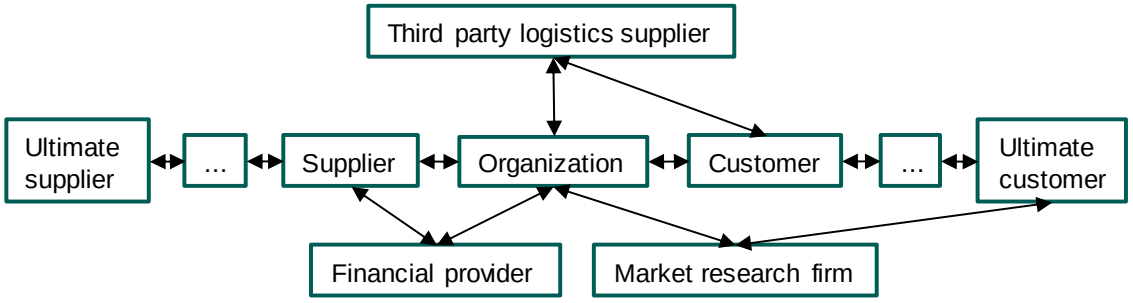


Figure 3.1.3. *An ultimate supply chain (adapted from Mentzer et al. 2001, p. 5).*

An ultimate supply chain consists of all the companies involved in all the upstream and downstream flows, starting from the ultimate supplier and ending with the final customer (Mentzer et al. 2001, p. 4). There can be several supplier's suppliers and customer's customers. A supply chain contains several companies' upstream and downstream (Mentzer et al. 2001, p. 3). All organizations which belong to the supply chain have to operate

together to ensure the complete integration of the supply chain as regards information and material flows (Childerhouse & Towill 2003, p. 17).

A supply chain management (SCM) is the systemic and strategic coordination of business functions. It is also the channel across business functions in a company and businesses within the supply chain which aims to develop the continuing performance of the companies and the supply chain in entirety. (Mentzer et al. 2001, p. 18.) A SCM has a need for integrated business processes with different parties of the supply chain (Lambert et al. 1998, p. 15). An objective of the supply chain management is to focus on the total system performance instead of optimization of individual logistics phases. The most general goal for the SCM is to provide better productivity. This may be achieved by reducing the cycle time for orders. (Helo & Szekely 2005, p. 5.) Croom et al. (2000, p. 68) suggest that companies try to gain advantage with comprehensive supply chains. They do not seek to have less costs or better gain by utilizing their partners in supply chain (Croom et al. 2000, p. 68). The purpose of supply chain management is that "a firm has the right product in the right place, at the right price, at the right time, and in the right condition" as Tarn et al. (2002, p. 28) point out.

Figure 3.1.4. shows how Mentzer et al. (2001, p. 19) perceive the supply chain management. The figure presents that all basic business functions have to be included in the supply chain management. The supply chain management can achieve all its potential if interfunctional coordination takes place. Furthermore, in order for a supply chain to reach its full potential, all supply chain flows should be included in the supply chain management. This figure shows that supply chains are often global, a fact which should be taken into account by the management. The final goals of supply chain management are to gain competitive advantage, lower costs and expand customer value and satisfaction. (Mentzer et al. 2001, p. 19.) Stefanou (1999, p. 800) agrees that a key point in the supply chain management are well-managed material and information flows, starting from the supplier and ending with the customer.

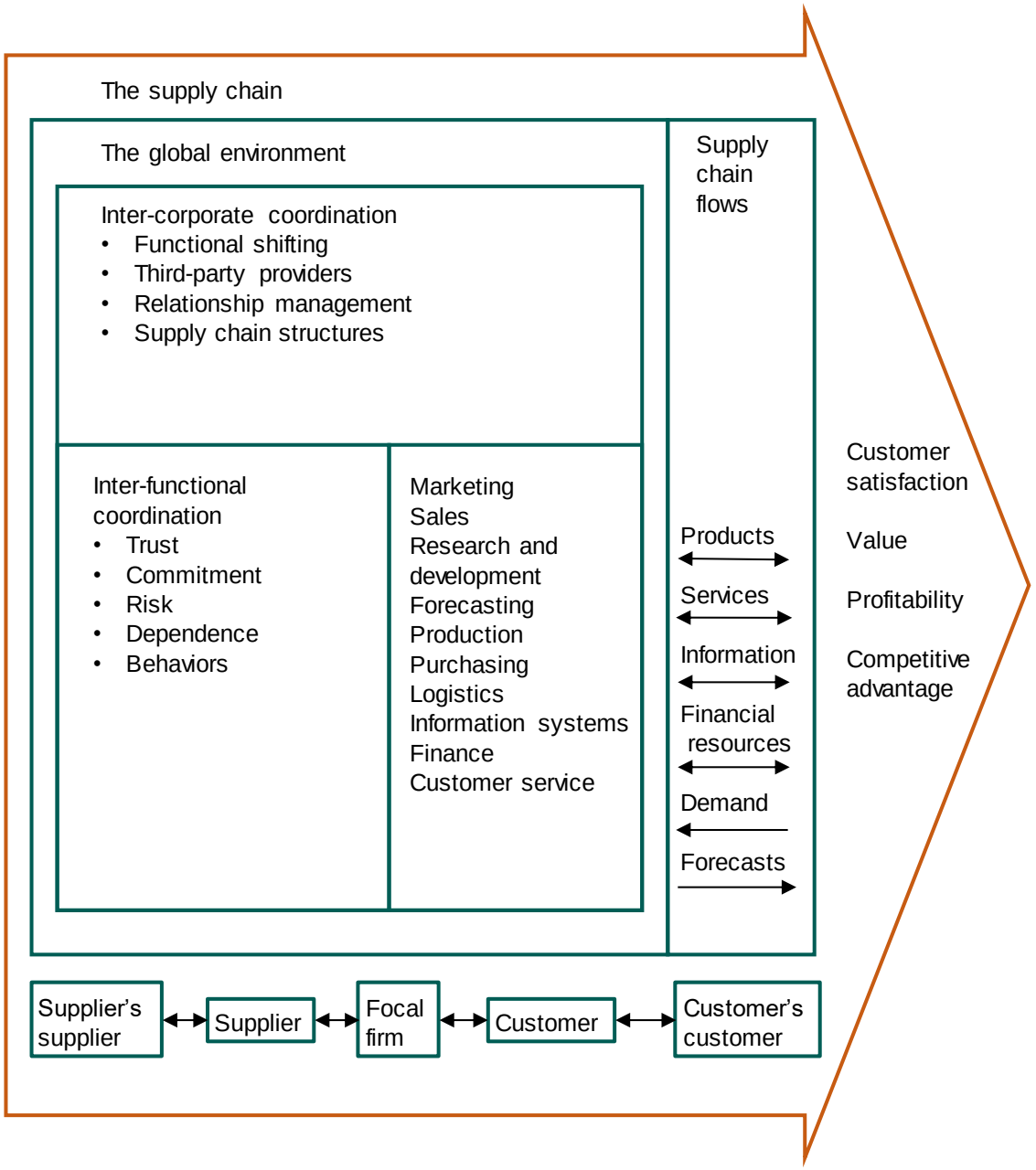


Figure 3.1.4. *A way to describe the supply chain management (adapted from Mentzer et al. 2001, p. 19).*

The word logistics is often perceived synonymous to the term supply chain management. However, there is a difference between the terms. Logistics includes planning, implementing and controlling flow of materials from suppliers to an organization and further to customers. Logistics usually refers to an individual company's point of view. Supply chain management, in turn, consists of the logistical flows, but also includes the customer order management and production processes, as well as the information flows which are essential in a supply chain. (Lummus et al. 2001, p. 431.) Logistical flows will be presented in the next chapter, and logistics itself in Chapter 3.2. Croom et al. (2000, p. 69) argue that the supply chain management consists of more elements than logistics activities

and planning of material and information flows both inside a company and between companies. There are several points which have been related to the supply chain management: purchasing and supply, logistics and transportation, marketing, organizational behavior, industrial organization, transaction cost economics and contract view, contingency theory, institutional sociology, system engineering, network, best practices, strategic management, and economic development (Croom et al. 2000, p. 69–70). Tapaninen (2013, p. 34) concurs that in addition to logistics, the supply chain management includes data processing, marketing and strategic planning. The supply chain management has become a more common term than the logistics (Tapaninen 2013, p. 34).

Subcontractors, manufacturers, wholesalers and retailers belong to a chain of buying and selling. Companies have partners in up- and downstream. Upstream forms a company's purchasing markets and downstream a company's sales market. These partners form an extended value chain. (Karrus 1998, p. 204.) The value chain is a chain of operations, for example procurement, production and distribution, which lead to adding value (Karrus 1998, p. 304). Croom et al. (2000, p. 73) emphasize that relationships between different parties in a supply chain are crucial. Mentzer et al. (2001, p. 2) argue that material flow is more effective if companies have closer relationships with suppliers.

Supply chain decisions can be divided in strategic and operational categories. Strategic decisions are connected to the company strategy. Operational decisions are mostly focused on daily operations. There are strategic and operational aspects in location, production, inventory and transportation areas, all of which are major decisions in the supply chain management. (Ganeshan & Harrison 2002, p. 2.) There are both static and dynamic dimensions in supply chain management. The static dimension refers to positions of inventories: where the warehouses should be located and how much stock there is in each location, how many warehouses are in use, how to centralize inventories or eliminate local inventories and how to locate consolidation points. Dynamic dimensions of supply chain management pay attention to the choice of a shipment mode, whether it is good to consolidate delivery routes and logistics service providers and if faster modes of transportation should be in use. (Croom et al. 2000, p. 73.) Supply chain performance meters consist of qualitative and quantitative measures. Qualitative performance measures include, for example, customer satisfaction, flexibility and supplier performance. These are measures which do not measure numerical aspects. Customer satisfaction is the degree how satisfied internal and external customers are with products and services. Flexibility measures how well the supply chain is able to handle occasional variation in demand. Supplier performance measures whether suppliers deliver materials on time and in prime condition. Quantitative measures are based on cost or customer responsiveness. For example, cost minimization and profit maximization are measures based on cost. Measures based on customer responsiveness are lead time minimization, customer response time minimization and product lateness minimization. (Beamon 1998, p. 11–12.)

Supply chain management is a broad concept which cross-cuts a company's operations. Several choices can be made in the supply chain management to realize each aspect of the process. A supply chain can be also measured in numerous ways. The next chapter will present the basic flows of the supply chain which cross-cut a company's operations.

3.1.1 Information, Material and Cash Flow

Supply chain consists of three main flows: information, material and cash (Karrus 1998, p. 214). Logistics can be seen as a system of several flows as well. A material, recycle, capital, information and organization flow are the main flows. When the other flows are fast, the capital flow is fast as well. (Karrus 1998, p. 72, 157.) Figure 3.1.1.1. shows logistical main flows in a simple chain.

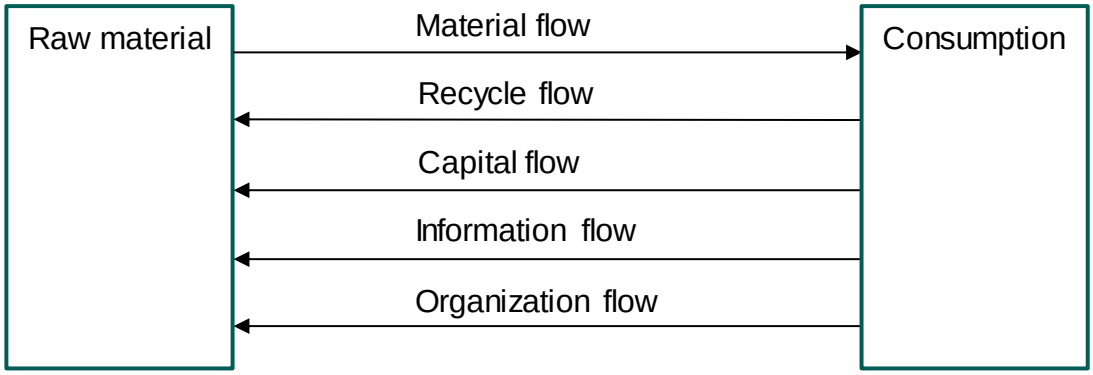


Figure 3.1.1.1. *Logistical main flows (adapted from Karrus 1998, p. 72).*

Because of globalization, companies have to coordinate material flow from and to the company more effectively than previously (Mentzer et al. 2001, p. 2). Goods movement in a logistics chain is described as material flow, which is one of the main flows of logistics (Karrus 1998, p. 308). By simplifying material flow, the supply chain can be integrated (Childerhouse & Towill 2003, p. 18). This means, among other things, that separate parties of a supply chain could work better together and the supply chain as a whole becomes more effective.

Information flow, the movement of information, is one of the main flows of logistics (Karrus 1998, p. 310). Information technologies enable a supply chain by providing transactions between different parties in the supply chain. The supply chain needs key data which is available in a single location. Alignment issues are easier to solve if information is freely available for use anywhere in the chain. Companies tend to see sharing information as a threat which may lead to a loss of power. (Croom et al. 2000, p. 73.) In contrast, the sharing of knowledge is generally considered important, especially within a company. Information is needed everywhere, and often it is also available everywhere. Finding the correct information can be challenging. International trade involves a lot of

exchange of information on how to order, confirm and bill transportation (Tapaninen 2013, p. 131).

Organization flow illustrates a service interface between two companies (Karrus 1998, p. 72). The service interface can be, for example, data exchange between organizations. Recycling means restoration of used and unused raw materials, components and products into industrial raw materials and reuse (Karrus 1998, p. 306). Chen et al. (2007, p. 218) define recycling channel as a channel where recyclable collectors, processors, junkyards and demand markets form a network, which handles the recycled material flows from sources to junkyards or demand markets.

Capital flow is one of the main flows of logistics chain where the movement of payments takes place (Karrus 1998, p. 309). Through strategy can be achieved money and it is called cash flow. It is decided in the strategy how money is used for different actions. (Ballou 2004, p. 57.) Without capital flow, there is neither movement of information nor material flow. Capital or cash flow is an important subject in this thesis, because the aim is to arrange deliveries with thinner cash flow. This will be possible by optimizing the order-to-delivery process. If the network design strategy is well-planned, significant cost savings can be reached (Ballou 2004, p. 57).

3.1.2 Order-to-Delivery Process

An order-to-delivery process (ODP) is presented from the beginning to the end in this chapter. The process includes, for example, customer service, ordering, logistics matters, forwarders and supply chain. Time, quality, cost and delivery reliability are important factors of the process. Delivery reliability refers to the gap between the promised terms of delivery and the actual delivery (Karrus 1998, p. 311). Those factors can be used as meters as well.

An order-to-delivery process is a process which starts when a customer needs certain goods and ends when the goods have been delivered to the customer (Forslund et al. 2008, p. 43). Viswanadham (2000, p. 183) adds that the order-to-delivery process means that buyers or customers are connected with sellers, and when the sale transaction is completed, cash is brought to the seller. This is a reason why an ODP is also related to an order-to-cash process (Viswanadham 2000, p. 183). According to Larson & Gammelgaard (2001, cited in Forslund et al. 2008, p. 42) the process contains the minimum of three actors: a customer, supplier and logistics service provider. Mattsson (2004, cited in Forslund et al. 2008, p. 42) analyses that the order-to-delivery process is one of the most critical processes in companies to administer – from the logistics' point of view at least. The process can be characterized as four sub-processes: customer's order, delivery sub-process at the supplier, logistics service provider's transportation and customer's goods receipt (Mattsson 2004, cited in Forslund et al. 2008, p. 42). The ordering process begins when a customer has a need to order and ends when the customer receives the order. The

supplier's delivery sub-process starts where the previous sub-process is completed and ends when the order is ready for shipping. The sub-process of transportation lasts from the ordered goods are ready for pick-up until the ordered goods are unloaded at the customer. The final sub-process, the goods receipt, begins when the customer receives the goods and ends when the goods are available for use. (Forslund et al. 2008, p. 43.)

An order-to-delivery process can be evaluated by the strength of lead time or on-time delivery. Lead time is the time between the awareness of the need to order and the moment when the order is received. (Blackstone & Cox 2005, cited in Forslund et al. 2008, p. 43.) Karrus (1998, p. 308) defines lead time as the time in which the product passes through the logistics system. Christopher (1998, p. 166) argues that efficient management of lead time is significant in reducing costs and improving customer service. On-time delivery means a delivery which is delivered at the agreed time and the ordered quantity corresponds with the delivered quantity. (e.g. Kallio et al. 2000, cited in Forslund et al. 2008, p. 43; Forslund & Jonsson 2007.) The process of increment value covers the entire chain of operations starting from a customer's needs and ending when the customer's needs have been met. Companies often have group of core processes that consist of cross-cutting function chains of customers' needs and a company and its stakeholders. The main processes of companies are development of new services, customer base management, delivery to the customer, customer service and business support functions. Delivery to the customer process consists of three parts: an order-to-delivery process of a standard product, offer-order-to-delivery process of a customizable product, and quotation-implementation process of a project delivery. (Karrus 1998, p. 186.)

A product life cycle starts from natural resources, which eventually need to be disposed. The life cycle includes manufacturing, packing and distributing of product, storage and transportation, purchase and sales operations, and, finally, marketing. (Karjalainen & Ramsland 1992, p. 39.) If the worth of the product is low, or if it cannot be stored for some other reason, it has to be manufactured on the basis of an order (Karrus 1998, p. 43). Stevenson et al. (2005, p. 869, 871) define make-to-order (MTO) products as products which are produced or designed only when the customer has confirmed the order. Companies need to be aware of customers' needs (Holweg & Pil 2001, p. 74). Otherwise, the product may be useless for the customer who ordered it – and other customers as well. A challenge of MTO parts is shortening of the total delay time. Shortening of the total period should not degrade the quality of the product or unduly raise the price of the product. (Karrus 1998, p. 46.)

According to Karrus (1998, p. 45), MTS is an abbreviation of manufacture to stock. MTS is an abbreviation of the term make-to-stock as well. Production in itself means producing of goods, materials, raw materials, components and services. Quantity based forms of production are mass production, serial production, production in small batches, and individual production. Mode of operation based forms of production are production to a warehouse, production for an order, assembly for an order, and planning and production for

an order. (Karrus 1998, p. 311.) In production, the main targets are to optimize scale, cost, quality, and time (Partanen & Haapasalo 2004, p. 213). All of these targets can be expanded to the whole ODP.

Purchasing is the search for and ordering of materials and services, as well as controlling deliveries. Analyzing the needs, sourcing, and searching options of supply, making requests for quotation, their evaluation, and negotiating procurement contracts are main tasks of purchasers. (Karrus 1998, p. 308.) According to Ballou (1999, p. 10), purchasing consists of supply source selection, purchase timing, and purchase quantities. The function of procurement is to guarantee the products, raw materials, components, and services that are necessary for operations of a company. The need for acquisition can be acquisition of raw material, component, material, investment, commodity, or services. Procurement is an interface for suppliers and subcontractors. Traditionally, one of the tasks of procurement is to invite tenders from suppliers in purchasing markets where standard components are available. Items that are adapted for customer needs require more cooperation and coordination in the chain. Collaboration in case of standard items is also important because a supplier may give good terms for an assured customer. (Karrus 1998, p. 205.) Therefore, the number of suppliers has been reduced in case of larger customers (Karrus 1998, p. 206). The goal of purchase is to obtain items at the lowest possible price. These items are stored in a warehouse to wait for their use. (Karrus 1998, p. 61.)

Ballou (1999, p. 9) divides information flows and order processing into three parts: methods of sales order-stock interface, order information distribution modes, and ordering guidelines. Mission of the sales is to take care that there is a sufficient quantity of material to be sold in all situations (Karrus 1998, p. 61). In DC, Prime and purchase team take care of material availability. Prime is a tool for the global inventory planning team, which calculates inventory levels and makes purchase requisitions. Another objective of sales is to achieve exchange transaction or an agreement of exchanges. Sales is further divided to sales for companies, consumers, and public sector organizations. (Karrus 1998, p. 308.) The customers of DCs are mainly companies, whereas SSOs sell products for consumers.

The supply chain consists of three modules: warehousing, handling, and transferring. Warehousing covers all the steps when a package is in a warehouse, store or held by the consumer. Loading, unloading, inspecting and marking are handling of the package. Transferring can be made by transportation equipment and cranes. The supply chain increases the price of the product, but not its value. Packaging planning should be optimal to keep the supply chain costs rational. The most strenuous stage of supply chain defines the strength of the package. Any external stresses must be taken into account in the supply chain. (Karjalainen & Ramsland 1992, p. 200.) Packaging will be handled more detailed in Section 3.3.

The total transportation distance may be minimized, or sales potential may be maximized by locating a plant in a certain way. The problem of a single plant is the distance between

customers or suppliers. (Karrus 1998, p. 79–80.) Key factors of placement of warehouses are transportation connections, distances and costs by using suitable mode of transportation for pick-up and delivery formats. From transportation perspective, warehouses should be located in favorable locations in relation to factories and main markets. Import and export warehouses are often located at the vicinity of ports or airports. (Karrus 1998, p. 86.)

Transportation inside the European Union is simple because of the few formalities. Customs declarations are not needed, if the goods are released for free circulation within Europe. INTRASTAT compiles statistics of trade inside Europe. Trading becomes significantly different when operating with countries outside of Europe. The EU has defined customs regulations for external trade. (Karrus 1998, p. 218.) The documents mentioned below are commonly used in international shipments:

- delivery instructions,
- Pro Forma invoice,
- commercial invoice,
- packing list,
- letter of credit,
- supplier's declaration,
- custom declaration,
- waybill or bill of lading,
- insurance certificate,
- certificate of origin,
- transmittal letter, and
- arrival notice (Karrus 1998, p. 218; Ballou 2004, p. 214–215).

A waybill is one of the most important documents of transportation. A transportation company receives the waybill when picking up the goods. Documents travel with the product until a consignee. (Tapaninen 2013, p. 134.) Documents will not be handled in further detail in this thesis.

It is important to ensure that no phase of the process is suffers during development. According to Ballou (2004, p. 57), if for example the quantity and place of warehouses are changed, it has impact on transportation, inventory moving, warehousing, and purchasing costs. Lean has become a popular strategy to plan the activities of enterprises. According to Cooper et al. (in Banister (edited by) 1998, p. 182), the object of lean supply chain is to eliminate the costly inventory. It is useful to consider the lean principle from different points of view. Cooper et al. (in Banister (edited by) 1998, p. 182) point out that if one or more stages of warehousing or even warehouses are eliminated, transportation costs increase. Just-in-time (JIT) is one aspect of lean supply. It may create a greater need for

transportation because demand of small consignments increases. (Cooper et al. in Banister (edited by) 1998, p. 182–183.) There are cost and service relationships between decision making of stock and transportation in inbound logistics. Freight costs decrease if the ordered quantity rises even slightly. This means that inventory quantity increases as well. (Carter & Ferrin 1996, p. 61.)

3.2 Logistics as a Part of Business

This chapter focuses on the ways how companies and their customers can achieve benefits, better quality and savings through logistics, and how they can aim for greater efficiency. Transportation is determined as an activity where something is transferred between two points by one or several modes of transportation (Davidsson et al. 2005, p. 257). Transportation management, inventory management and value added services are three main functions of logistics management (Aghazadeh 2003, p. 50). Managing stocks and transportation modes are important factors which affect cost and delivery time (Croom et al. 2000, p. 73). One of the key objectives of logistics is efficiency. Assessment of its volume and time indicators as well as costs and quality need to be taken into account. (Karrus 1998, p. 115.)

Logistics is comprehensive management and development of material, information and capital flow, procurement, production, distribution and recycling, offering of service and support, warehouse, transportation and other value adding services, customer service, and relationships (Karrus 1998, p. 13). According to Aghazadeh (2003, p. 51), logistics means managing the movement and storage of goods and information related to material flow from production to the customer. Tapaninen (2013, p. 34) determines logistics as controlling of material flow from a source of the raw materials to an end customer so that the product is available at the right time in the right place, and the costs associated with operations, as well as other disadvantages, such as negative environmental impacts and safety risks, are minimized. In addition to material flow, which includes transportation and storage, logistics also includes information and cash flow. In addition, social and environmental impacts have to be regarded. (Tapaninen 2013, p. 34.) A common feature for definitions is the duration. Logistics takes place from acquiring material until the material has been delivered to the end customer. Another feature is that logistics includes all phases between acquiring the material and the customer's reception of the final the product. Logistics is the management of all of these stages.

McKinnon & Woodburn (1993, cited in McKinnon, in Banister (edited by) 1998, p. 97) divide logistical decision-making for four levels, which may have an influence on freight movement. The decisions define logistic structures, pattern of trading links, scheduling of product flow, and management of transportation resources. Logistic structures include numbers, locations and quantity of mills, warehouses, and terminals. Pattern of trading links are commercial decisions for handling sourcing, subcontracting, distribution, and trading partners. Scheduling production and distribution functions lead to freight flows.

(McKinnon, in Banister (edited by) 1998, p. 97–98.) Distribution is a function which serves to supply the product from production to the market and end customers (Karrus 1998, p. 306).

Logistics is a complex area. It contains strategic, tactical, and operational sides (Davidsson et al. 2005, p. 258). According to Karrus (1998, p. 12), the management of manufacturing, raw material flow, distribution, services, information flow, and cash flow require comprehensive knowledge and understanding of the assemblies. Logistics experts need management and analyzing skills and solution abilities. They need to follow the development of society, legislation, competition, and partners. (Karrus 1998, p. 12.) They must take several issues into consideration. Karrus (1998, p. 13) claims that material functions form the base of logistics. A core of material functions is material purchasing, warehouses, material handling which means transferring material or products between manufacturing points and distribution systems. Goods logistics contains purchasing, productions, and distribution tasks organized into basic functions: storage, ordering, and transportation in many phases of a process. (Karrus 1998, p. 13.)

Logistics can create value for customers, suppliers and other stakeholders of the company (Ballou 2004, p. 13). A value chain consists of a chain of functions through which a company generates value and competes in its domain with other companies which produce value to clients. In value chain thinking, suppliers are called upstream and customers are called downstream. (Karrus 1998, p. 14.) Products and services have value only if they are available to customers when and where needed (Ballou 2004, p. 13). The review of material flow is not enough in itself; cash flow needs to be managed if the goal is to develop overall operations. The third essential factor is information. (Karrus 1998, p. 17.) Information and communication have an increasingly important role in the development of efficient logistics solutions in relation to quantity, quality and time. Information flow is important because it removes the need for speculation in production or warehouse operations. The speculative productions would tie up capital and generate sales risks. In addition, speculation would cause limitations of offering and weakening of supply conditions. (Karrus 1998, p. 17–18.)

According to Tapaninen (2013, p. 36), the supply chain invariably binds capital when a product is in a warehouse or in transportation. Reduction of capital tied up in warehouses is one of the first actions for a company who wants to increase competitiveness and reduce logistics costs. The reverse side is that service level weakens because a product may run out. This means that the customer does not get the product at the time of need. (Tapaninen 2013, p. 36.) In Finland, a storage takes 10–15% of sales income while total costs of logistics are 20–30% of sales margin (Sakki et al. 1996, cited in Karrus 1998, p. 137). One way to reduce logistics costs is by reducing the costs of transportation. Distance, economies of scale, trade balance, value and type of product, competition and transportation connections and ports, and other trading conditions affect transportation costs. (Tapaninen 2013, p. 39–40.)

Customers are not willing to pay transportation or storage if it does not benefit them. This means that transportation or storage should affect to the availability of the product, improve or maintain the quality of the product, or decrease price of the product. (Tapaninen 2013, p. 34.) If a company has low logistics costs, it can use resources, for example, to product development or customer service. This way competitiveness and productivity increase. Logistics costs have increased in 21st century due to the price of oil and the rise of transportation costs. (Tapaninen 2013, p. 35.) Because of the higher logistics cost, transportation should be carefully planned. Total annual transportation cost = *declared weight per shipment * shipping rate per some quantity * number of shipments per year* (Carter & Ferrin 1996, p. 62).

Logistics is not only a cost factor. It is one of the key ways to achieve a broader group of customers and take advantage of decreasing a cost of margins caused by a volume. Logistics may cause also a central part of the service experienced by the customer. Logistics may offer one of the best ways to develop profitability of operations. (Karrus 1998, p. 137–138.) For example, logistics tries to minimize unnecessary transportation and storage (Tapaninen 2013, p. 34). Also Karrus (1998, p. 107) argues that an objective of transportation optimization is to minimize the overall cost. Optimization means searching of objective factors of the highest value of the compound from among limiting factors (Karrus 1998, p. 308). Creating new or improving old policies are ways to develop logistics efficiency. By strengthening its existing practices, a company may attempt to improve its procedures within the prevailing constraints and opportunities. (Karrus 1998, p. 115.)

Environmental situation should be taken into account when planning transportation. Supply chain developments are not same for all companies and industries (Cooper et al., in Banister (edited by) 1998, p. 177). Frequent deliveries may raise transportation requirements and increase environmental pollution. It is worth considering if frequent delivery is needed, or if less frequent delivery would meet customers' requirements. Because frequent delivery is more expensive, economic pressure plays a role as well, and customers may not even need frequent deliveries. (Cooper et al., in Banister (edited by) 1998, p. 180.) Metso has both fast and standard deliveries. At times, customers need as fast delivery as possible. According to Hill (1994, cited in Cooper et al., in Banister (edited by) 1998, p. 180), the availability of stock, order cycle time, frequently of delivery, on-schedule delivery, and reliability of delivery are the main elements of customer service. Fredericks & Salter II (1995, p. 29) suggested already in the 1990's that it is more important to increase customer loyalty than satisfy customers. Customers need reliable suppliers and it is important to build a relationship with the customer.

Quality of service is one of the most important selection criterion for a supplier for many customers. The meters are developed to fit mode of operation and the target customer base. For the most part, meters of quality of service are related to availability, delivery reliability and order-to-delivery delay. (Karrus 1998, p. 119–120.) Several metrics are

also linked to basic elements of supply chain: planning, sourcing, producing, and delivering (Gunasekaran et al. 2001, p. 84). Order-to-delivery delay is the time from ordering to the corresponding delivery to a customer (Karrus 1998, p. 310). If material is not available when customers make the order, they may cancel the order. Delivery reliability can be calculated as the difference or ratio between the promised and actual delivery time. (Karrus 1998, p. 119.)

3.2.1 Features of Transportation and Incoterms

According to Logistiikan maailma (2016b), existing transportation facilities and their properties have an impact on the choice of mode of transportation. These include selection of services, service capability, transportation costs, routes, transit time, reliability and additional features or restrictions of services. Several issues need to be considered when selecting a mode of transportation:

- import and export countries,
- size of a consignment,
- urgency of transportation,
- state of matter and characteristics of the goods,
- the value of the goods,
- susceptibility to damage of the goods,
- packing,
- conditions for loading and unloading of the goods,
- temporary storage and handling of cargo,
- terminal circumstances,
- specific conditions and restrictions on countries of a dispatch, recipient, or transit, and
- own special requirements of the mode of transportation. (Logistiikan maailma 2016b.)

Globalization increases significance of logistics (Karhunen et al. 2004, p. 28). Since Metso operates around world, dynamic logistics is essential. Chopra & Meindl (2007, p. 410) highlight that transportation strategy needs to be aligned with competitive strategy. In addition, both in-house and outsourced transportation should be taken into consideration (Chopra & Meindl 2007, p. 410) and the more suitable option should be chosen. Outsourcing will be discussed in more detail in Section 3.2.3.

Incoterms are optional rules between a seller and buyer, while the contract with a carrier is a separate agreement. The aim of incoterms is to streamline trade. International Chamber of Commerce maintains a collection of incoterms. The latest edition is from the year 2010. (Tapaninen 2013, p. 88.) This edition contains 11 different incoterms defined by international trade practice (Ramberg 2011, p. 8, 25). In critical points of incoterms are

when the goods are transferred from a seller's liability to a buyer's responsibility (Tapaninen 2013, p. 88). There are four categories of the incoterm rules. The E-term means that the goods are placed at the disposition of the buyer. F-terms mean that main carriage is not paid by seller, while in C-terms the seller pays it. D-terms are called delivered terms. (Ramberg 2011, p. 50, 52, 57.) Table 3.2.1.1. shows four incoterm groups. EXW (Ex Works (named place)), FCA (Free Carrier (named place of delivery)), CPT (Carriage Paid to (named place of destination)), CIP (Carriage and Insurance Paid to), DAT (Delivered at Terminal), DAP (Delivered at Place (named place of delivery)) and DDP (Delivered Duty Paid) are suitable for every mode of transportation (Tapaninen 2013, p. 89; Logistiikan maailma 2016a).

Table 3.2.1.1. *Incoterms in groups.*

E-term	F-terms	C-terms	D-terms
EXW	FCA	CPT	DAT
	FAS	CIP	DAP
	FOB	CFR	DDP
		CIF	

The buyer and seller agree on deliveries and responsibilities in mutual trade agreements (Karhunen et al. 2004, p. 229; Logistiikan maailma 2016b). By choosing an incoterm, the buyer and seller choose the party which is responsible for implementing transportation (Logistiikan maailma 2016b). When an owner of the goods change, there are always at least three flows present: information, material and cash flow (Karrus 1998, p. 227); these were discussed in Section 3.1.1.

3.2.2 Modes of Transportation

This section discusses the general modes of transportation and their characteristics. Operating of transportation will not be discussed in this thesis, because Metso does not operate deliveries. Instead, transportation is outsourced for 3PL partners.

The choice of transportation mode can be determined by several aspects. The basic modes of transportation and their characteristics will be discussed below. The modes of transportation are road, waterway, air, railway, and combined transportation (Tapaninen 2013, p. 43). Pipeline transportation is also a way to deliver goods (Tapaninen 2013, p. 43). In this thesis, road, ocean, air, and courier transfers are emphasized. Railway, intermodal transportation, and pipes have been excluded, because these transportation modes are not used by the selected units of Metso Minerals. Large-scale industry requires effective transfer of raw materials, components and manufactured products over considerable geographical areas (Karrus 1998, p. 96).

Cost, delivery time, delivery reliability, and delivery accuracy are the most important aspects which need to be taken into account when choosing the mode of transportation (Logistiikan maailma 2016b). The time reserved for transportation often defines the mode of transportation. If the product is expensive and light, a fast delivery is desirable. However, there are several points that need to be considered when choosing a mode of transportation: the size of the product, distance between departure and delivery places, schedule, packages, flexibility of transportation, traceability and variability of the product and possible hazards of the product. (Tapaninen 2013, p. 44.) Davidsson et al. (2005, p. 257) state that the selection of the mode of transportation is determined by the category of goods, the speed of a shipment, the handling costs, the distance, and flexibility. Agarwal (2015) mentions almost the same aspects: cost of service, speed of transportation, flexibility, regularity of service, safety, nature of commodity and other considerations including, for example, warehousing, packing, loading, and unloading. Transportation decisions often are connected with inventory decisions (Ganeshan & Harrison 2002, p. 3).

Road transportation is the most flexible in a scale of the basic modes of transportation (Karrus 1998, p. 97; Tapaninen 2013, p. 43). It is fast in short distances (Davidsson et al. 2005, p. 257). Loads can be transportationed by road directly from a starting point to a destination (Karrus 1998, p. 97). Road transportation uses in various combinations of equipment from different capacity classes. These combinations share transportation functions to various carriers and vehicles. Laws place general requirements for equipment, personnel and concessions. Dimensional and weight restrictions, requirements and regulations depend on vehicles and form a complex network of rules. (Karrus 1998, p. 98.) Road transportation is the largest and the most important mode of transportation in domestic transportation in nearly every industrialized country. In addition, road transportation is frequently used for export shipments within one continent. Road transportation is used for distribution transportation and for trunk transportation between terminals. (Tapaninen 2013, p. 43.) Karrus (1998, p. 97) agrees: collection and distribution activities can be carried out using road transportation. Generally, it is the inevitable mode of transportation for the first and final steps in the transportation chain. Because of these reasons, road transportation is the most commonly used mode of transportation. (Davidsson et al. 2005, p. 257.)

A significant part of tonnage of international carriage is transferred by the sea (Karrus 1998, p. 99). Excluding recessions and global wars, maritime transportation has increased throughout the known history. Because maritime transportation is inexpensive, it has played a crucial role in globalization. A number of sea deliveries has increased when gross domestic product has increased. Maritime transportation takes place mainly between industrial countries. (Tapaninen 2013, p. 13.) Maritime transportation is ideal for non-urgent transportation needs and affordable products (Tapaninen 2013, p. 43). However, sea transportation requires a large number of inventory (Ganeshan & Harrison 2002,

p. 3). Sea transportation is often a part of a broader transportation chain. Transportable items arrive to ports and depart from them in trucks or by rail. (Karrus 1998, p. 99–100.)

Air freight is an expensive and reliable mode of transportation (Ganeshan & Harrison 2002, p. 3; Tapaninen 2013, p. 43). It is an efficient way to deliver small and light goods (Tapaninen 2013, p. 43). Air transportation is a fast transportation mode (Karrus 1998, p. 101; Ganeshan & Harrison 2002, p. 3; Tapaninen 2013, p. 43). Indeed, it is the fastest mode of transportation on intercontinental routes (Karrus 1998, p. 101). Air transportation does not require a large quantity of safety stocks (Ganeshan & Harrison 2002, p. 3), unlike maritime transportation. Urgent and valuable deliveries are usually carried by air freight (Davidsson et al. 2005, p. 257; Tapaninen 2013, p. 43). Air freight is the main mode of transportation for urgent and small deliveries (Karrus 1998, p. 101). For example, expensive spare parts warehouses are centralized and located close to air transportation hubs. These warehouses are a significant customer segment for air transportation. (Karrus 1998, p. 101–102.)

Nearly all air and sea transportation chains require transportation by road as well. Combined transportation is a term for this phenomenon. Pick-up and distribution transportation are arranged by road, whereas trunk transportation is operated by waterway vessels. There is a difference with the term intermodal transportation which means that material which is in the same transportation unit throughout transportation time but the transportation unit is transferred by a number of different modes of transportation. A transportation unit can be a container or a trailer. (Tapaninen 2013, p. 43–44.) Tseng et al. (2005, p. 1665) consider land logistics important, because it broadens transportation services for air and sea transportation from airports and seaports. If logistics structures are developed, the parties responsible for the logistics chain should be selected on the basis of reliability (Tapaninen 2013, p. 44).

Courier service can use several modes of transportation; road transportation and air transportation are the most common modes. Karrus (1998, p. 307) defines courier service as a fast international delivery service specialized to deliver letters and small packages. Chopra & Meindl (2007, p. 388) refer to the service delivering small packages and letters as package carriers. Certain parts offered by Metso are extremely small and light but also valuable. For them, an ideal mode of transportation is air courier or air freight. In comparison, Metso’s larger and heavier parts may be non-urgent so they are delivered by oceanfreight.

The basic modes of an actual transfer are collection, transfer, trunk, distribution, and return transportation. Collection transportation is used, for example, for special transportation. Transfer orders are orders between warehouses and manufacturing plants within an organization. Trunk transportation is transportation of products between the main storage points the direction of distribution flow to the customer. Products are delivered close to markets or to a customer in distribution transportation. (Karrus 1998, p. 105–106.) This

thesis focuses on transportations arranged from a supplier to Metso Minerals or from Metso Minerals to a customer.

Generally, light and expensive goods should be delivered by air freight, whereas heavy and low-priced materials need to be transported by ocean freight. Road transportation is useful within a continent, as well as for distribution transportation and trunk transportation. Courier services can be used for urgent shipments and they may arrange truck or air deliveries depending on the requirements.

3.2.3 Outsourcing, Third-Party Logistics and Fourth-Party Logistics

Outsourcing concerns operations, which are generally executed internally and then transferred to a third-party service (3PL) provider. Companies use outsourcing because 3PL providers are stronger on the outsourced area than the company that uses their services. (Gadde & Håkansson 2008, p. 23–24.) Karrus (1998, p. 311) states that outsourcing means moving the operations of a company to another party which often means a separate service company. The logistics service industry has faced changes as instead of individual functions, modern companies outsource several of their functions. Logistics service providers offer various logistics services. (Bowersox et al. 2007, cited in Win 2008, p. 675.) It is common to outsource part of company's supply chain operations to numerous service providers (Cheng et al. 2008, p. 466) instead of a single company. Logistics service companies execute client orders: these include logistical tasks like warehousing, transportation and distribution without the ownership of the product. Further processing like assembly can be included in logistical tasks. (Karrus 1998, p. 224.) The use of logistics service companies has increased globally. Companies want to focus on their core business, which means that responsibilities such as warehousing and distribution are increasingly left to logistics service companies. (Karrus 1998, p. 224–225.) Core processes consist of operation chains crosscutting the needs of customers, companies and stakeholders (Karrus 1998, p. 313). Logistics service companies have centralized their specific regions, formed own networks, or built entities of special services which are appreciated by their customers (Karrus 1998, p. 225).

Logistics services are logistics operations available for purchase. Services may be internal or external and they can be outsourced or internalized. There are several options for purchasing logistics services. The purchase may be individual or long-term contracts may be arranged. Outsourcing and internalizing are often strategical choices. (Karrus 1998, p. 226.) In the 1970s, companies commonly used their own transportation vehicles and personnel for export deliveries. This policy has since become uncommon and exporters and importers generally order their transportation services from transportation companies. (Karrus 1998, p. 111.) However, Win (2008, p. 675) demonstrates that companies have

realized that, in order to remain competitive, it is important to focus also non-core operation such as the management of a supply chain. Christopher (1998, p. 15) disagrees and claims that companies often focus on their special advantages, while the rest of the operations are outsourced. A typical problem of transportation companies is an inaccurate or incorrect delivery address which may cause delays in deliveries. Established transportation partners can bring benefits of knowledge to company, because adaptation to a company's practices generally takes considerable time. (Karrus 1998, p. 111–112.)

All logistical tasks can be purchased from subcontractors as services. Basic logistical services are transportation, warehousing, and freight forwarding services. Certain of the main basic flows can be treated also other than logistical services. (Karrus 1998, p. 226–227.) Figure 3.2.3.1. presents basic services of logistical main flows.

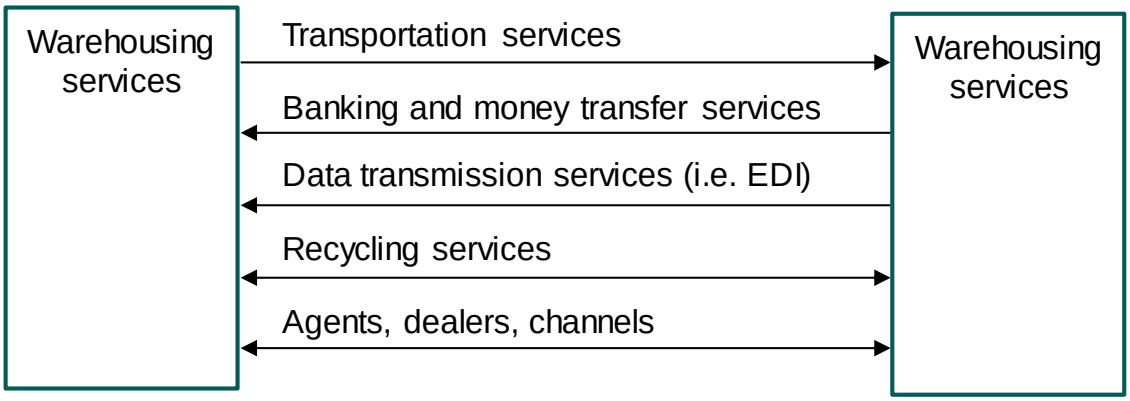


Figure 3.2.3.1. *Basic services of logistical main flows (adapted from Karrus 1998, p. 227).*

Basic types of logistical services are transportation services, warehousing services, freight forwarding services, data transmission services, and value-added services. Transportation services offer transportation capacity or flexible and tailored overall transportation systems. Transportation can be acquired for an occasional need, through partner agreements or as a continuous subcontract. Warehousing is another basic form of services. It may include rental of storage space or a warehouse managed by a third-party. Forwarding services are combined services. The forwarder takes care of all operations during transportation from start to finish, including all required paper work such as customs declarations. Most of forwarding companies offer several services in combination relating to logistical flows. Data processing services can be purchased as well. They consist on EDI messages, conversion of messages and temporary storage. (Karrus 1998, p. 227–231.) Electronic Data Interchange (EDI) is transfer of business documents in a standard electronic format between computers by using information and telecommunication technology (Karrus 1998, p. 305; EDI Basics 2016). Value-added services are operations that are expanded beyond basic logistics. Certain services, which may not be perceived as a part of logistics, are nevertheless classified under the term. For example, money transfer services are support functions that enhance logistics. (Karrus 1998, p. 231–232.)

Third-party logistics (3PL) providers, such as forwarders or carriers, are commonly used by organizations (Cheng et al. 2008, p. 466). Third party can be a transportation company, warehouse operator or contract producer. 3PL providers may have several functions, such as managing warehouses, consolidating shipments, choosing forwarders, providing logistics IT systems, and as managing and operating shipments. They can also agree rates, arrange returns for products, replenish stocks, and assemble products. (Aghazadeh 2003, p. 50, 52.) Chopra & Meindl (2007, p. 426) emphasize transportation, warehousing and IT within the supply chain. Several companies benefit from third party logistics (3PL): they bring a competitive advantage. Benefits of 3PL include lower costs, developed competence, market knowledge, data access, better operational efficiency, customer service, flexibility and the possibility to pay attention to the core business. The need for personnel decreases and transportation and distribution costs are reduced. In addition, the company does not need to tie assets in equipment, supply chain softwares or warehouse buildings. In order to an organization to benefit from 3PL as much as possible, proper communication and engagement between the companies are vital. 3PL differs depending on an industry. Companies may use one or several 3PL providers. (Aghazadeh 2003, p. 50–51, 53.)

Supply chain integration may be operated by outsourcing parts of companies' businesses to fourth party logistics (4PL) companies. 4PL provider is an integrator who arranges information technology and supply chain integration. 4PL integrators exploit the responsiveness of IT and know-how, cover the internal physical facilities, technology competence and resources in planning, evaluating, coordinating, and controlling. (Cheng et al. 2008, p. 466–467.) Win (2008, p. 677) identifies 4PL to be "an independent, singularly, accountable, non-asset based integrator of a client's supply and demand chains". 4PL enables companies to have one point of accountability over supply and demand chains. 4PL helps companies to build better relationships with different parties in the supply chain, cut costs, and develop flexibility to handle supply and demand uncertainties. (Win 2008, p. 675.)

4PL provides help companies to manage the involved 3PL providers. At the same time, 4PL integrators solve needs between the company and resources of 3PL and IT providers. (Win 2008, p. 676.) The key factors of 3PL and 4PL are presented in Table 3.2.3.1.

Table 3.2.3.1. *Key factors of 3PL and 4PL (adapted from Win 2008, p. 684).*

Factor	**3PL**	**4PL**
Asset basis	Asset based (e.g. warehouse/transportation)	Non-asset based (except perhaps IT systems)
Accountability	Part (in conjunction with internal resources and/or other 3PL's)	Total singular accountability (as if internal)

Role	Logistics (typically)	Logistics, supply and demand chain integration
Business impact	Influences time and place utilities	Controls time and place utilities while also influencing form and possession utilities
Performance/success measurement	Cost	Value creation within client organization

Metso uses third party logistics. Almost all shipments are delivered by 3PL providers. In addition, a few of the warehouses are outsourced. The selection of 3PL and 4PL partners will not be handled in this thesis.

3.3 Warehouse Operations and Packing

This chapter discusses operations of warehouses and efficient ways to pack certain kinds of orders. Warehouses are a necessary part of the suppy chain (Gu et al. 2007, p. 1). A warehouse is physical space: it is a building for storing materials or goods. A warehouse can be also a manageable logistics unit. (Karrus 1998, p. 27.) On the other hand, an inventory can consist of the current assets or their quantity (Karrus 1998, p. 312). Often only small quantities of materials are kept in a warehouse and the goods pass quickly through the supply chain (Chow et al. 2006, p. 561). Basic warehouse functions are receiving, storage, order picking and shipping. Other functions are buffering material flow, consolidation of products, and value-added processes like kitting and labeling. (Gu et al. 2007, p. 1.)

Traditionally warehouses receive items from suppliers and put them to stock. Receiving is an interface for the incoming material flow. (Gu et al. 2007, p. 1, 4.) A receipt in a warehouse is a significant partner of a buyer. They may investigate if a supplier has fulfilled the promise of delivery. Inbound shipments are replenishment, transit, or return shipments. (Karhunen et al. 2004, p. 374.)

The picking starts when a customer order comes in. Warehouses may also assemble items for a shipment (Gu et al. 2007, p. 1). Gagliardi et al. (2007, p. 2016) see picking as an important factor. Picking starts the preparation of a customer delivery (Karhunen et al. 2004, p. 378). There are four order picking strategies: discrete, zone, batch, and wave, which define how materials are presented in a picking list and how they are picked. Wave picking means that the picker collects orders so that the needed shipping schedule can be reached. (Gagliardi et al. 2007, p. 2012.) Wave picking is the most suitable strategy for Metso Minerals because Metso Minerals' warehouses use route schedules to tell a timetable for each order. Other strategies will not be handled here because picking is not the

main point of this thesis. Karhunen et al. (2004, p. 378) divide picking methods to two main groups depending on whether the picker retrieves the goods or the items are delivered to the picker. Effective picking means that suitable picking routes are formed (Karhunen et al. 2004, p. 378). Companies may perform better by reducing stock-outs on the shelves during the picking process (Gagliardi et al. 2007, p. 2016).

Logistic packaging planning takes into account all of the factors affecting directly or indirectly to the packaging assembly. It focuses on the packaging combination. Unit of packaging, consumer packaging, store packaging, transportation packaging, and unit load may be included in the combination. (Karjalainen & Ramsland 1992, p. 39.) Ballou (2004, p. 13) sees protective packing as a support function of transportation, inventory keeping, warehousing, and material handling. Packing is important for logistics planning, because weight, volume, and shape of the package are more significant than the corresponding properties of products (Ballou 2004, p. 66–67). Main functions of the package are to protect, market and carry the product, and to address goods to the named customer (Karjalainen & Ramsland 1992, p. 27; Karhunen et al. 2004, p. 381). Planning a sufficient and economic package which does not protect too well is a complicated process (Karjalainen & Ramsland 1992, p. 27). The target of packing standards is to reduce costs and simplify operations. Packing standards are divided into three parts: product standards in which have been defined features and dimensions of the product, method standard which defines analysis or test methods of a product, and communication standard which aims to unify terminology and symbols in different countries. There are international, national, and regional standardization. (Karjalainen & Ramsland 1992, p. 13.)

Wood is one of the oldest packing materials (Karjalainen & Ramsland 1992, p. 109). For example, pallets, which are the basis of the distribution, are normally made of wood (Karjalainen & Ramsland 1992, p. 109; Ballou 1999, p. 261). A wood package is mostly used in export shipments for products that need high protection and for heavy products. The wooden package protects a content from hits. In addition, wooden packages are stackable, prevent pilferage, and facilitate handling. The most common types of wooden packages are a box and cage. (Karjalainen & Ramsland 1992, p. 109.) The units of Metso that were selected for this thesis use mainly boxes and pallets for transportation. Fiber-based packing materials such as paper, carton, and cardboard packages are widely used in the world (Karjalainen & Ramsland 1992, p. 50). Large packages are picked mainly for pallets and small items for cartons (Karhunen et al. 2004, p. 381). According to Karjalainen & Ramsland (1992, p. 111), certain relief supplies are needed for packaging. These include shutters, closing and binding supplies, cushioning and support materials, glues and lacquers, printing of package, and printing inks (Karjalainen & Ramsland 1992, p. 111, 115, 118, 122, 124, 132). Plastic is used for several purposes (Karjalainen & Ramsland 1992, p. 76).

Material handling depends on the size of goods (Ballou 1999, p. 261). Unitizing means the formation of an appropriate consignment which is assembled or bound so that it can

be transferred by auxiliary equipment. One of formation methods of unit load is a formation of a pallet load. A container can form also a unit load. (Karjalainen & Ramsland 1992, p. 202.) A pallet is a base level for compilation, warehousing, handling and transportation in a form of the unit load. Pallets enable handling of large quantities of goods effortlessly and promptly. (Karjalainen & Ramsland 1992, p. 202.) A feature of pallets is their varied size (Ballou 1999, p. 261) but they also have certain disadvantages. Pallets' weight and volume increase the transportation costs (Karjalainen & Ramsland 1992, p. 206). Unitizing the load for export is more complicated because transportation routes and modes are different in different countries. Furthermore, warehousing causes static burdens for packages and properties of warehouses depend on the requirements of products. (Karjalainen & Ramsland 1992, p. 210.) Certain products must be stored indoors, while others can be stored outdoors. For example, at Metso Minerals the wear parts can be stored in the yard.

All modes of transportation have their own special features which cause typical strains for this mode of transportation (Karjalainen & Ramsland 1992, p. 212). The mode of transportation should be known when packing so that the right package could be chosen. However, Karjalainen & Ramsland (1992, p. 212) argue that in all modes of transportation the handling of material is similar in many respects. According to Karjalainen & Ramsland (1992, p. 212–213), there are certain basic requirements for packages regardless of the mode of transportation. Firstly, the product should fill the package wholly. The package should be dimensioned so that it can withstand variation of temperature and humidity during the transportation. Shock absorber must be sufficient and the product has to be unitized so that it can be handled with a forklift. Standards need to be respected, and the attachment and lifting points should be marked when necessary. (Karjalainen & Ramsland 1992, p. 213.) Goods are normally shipped through shipping docks (Gu et al. 2007, p. 4). Small packages can be consolidated to improve efficiency (Ballou 1999, p. 261).

According to Karjalainen & Ramsland (1992, p. 215), the primary threats in road transportation are breakage and degradation of the goods. These threats can be avoided by unitizing the goods. The carrier is responsible for the package, its damage, loss and, delay in transit from a moment it has received the package until it has assigned the package to the receiver. (Karjalainen & Ramsland 1992, p. 215.) Contracts should include complete information; they are useful if something unplanned happens (Chopra & Meindl 2007, p. 514). A package can never be too sturdy for maritime transportation. The conditions of the destination port have to be taken into account when packaging the product. A container is a removable cargo space which can endure stress. However, special attention needs to be paid to stuffing a container and supporting its contents. (Karjalainen & Ramsland 1992, p. 217–218.) During air transportation, the product should be protected against dirt, dust, and friction. Because air transportation is fast and expensive, the value of the delivered material should be high compared to its weight. In addition, preservation

of the condition of the goods or timeliness requires rapid transportation. (Karjalainen & Ramsland 1992, p. 219.) All of the transportation modes have their own dynamic stresses and stacking heights (Karjalainen & Ramsland 1992, p. 215, 217, 219).

In addition to different types and sizes of packages and different transportation modes, other issues may need to be considered as well. According to Tapaninen (2013, p. 114), hazardous cargoes include solid, liquid or gaseous substances, which can damage the environment, property, and people or other living creatures. Radioactive, oxidized, toxic and explosive substances are examples of hazardous cargo. Several consumer goods, such as aerosols and paints, are treated as hazardous substances. It is crucial to know the physio-chemical characteristics of the hazardous substances because the substances can react differently if they come into contact with, for example, water. Different categories for hazardous materials have been developed to ensure that their transportation requirements are met and the procedures in accident situations are evident. (Tapaninen 2013, p. 114.) Dangerous goods need special packaging. The package has to be able to withstand stress during transportation. Dangerous goods should not damage the package or be able to form hazardous compounds with it. The package must be able to withstand pressure fluctuation as well as mechanical, chemical, and climatic stresses. Packaging requirements and laws vary according to the mode of transportation. (Karjalainen & Ramsland 1992, p. 224.)

Turnaround describes the effectiveness of the use of bonded capital for a warehouse. It is a ratio of sales to the average amount of material stock during a given time period. (Karrus 1998, p. 307.) Storage cost is the sum of three main cost factors: handling, space, and capital. This sum is calculated for a time period. In comparison, warehouse costs are the capital invested costs of warehouses. The costs of warehouse operations are caused by construction and existence of warehouses. These include, for example, investment costs, costs of labor, internal transfers of stock, wastage, and insurances. (Karrus 1998, p. 312.) In comparison, Gu et al. (2007) mention storage, inventory, material handling, picking, equipment, operational, and training costs as costs of warehouses. If production and consumption progress at different speeds, the only option may be to use storages to buffer the fluctuation of supply (Karrus 1998, p. 26). Warehouse operations are economical when there is no unnecessary lack or excess safety stock (Karrus 1998, p. 27). According to Karrus (1998, p. 27), spare parts stocks are more similar to safety stocks than use stocks.

3.4 Information Technology Systems in a Supply Chain

Information is vital for decision making in a supply chain, whereas information technology (IT) brings mechanisms for acquiring and analyzing information so that efficient supply chain decisions can be made (Chopra & Meindl 2007, p. 495). IT contains five parts: the study, design, development, implementation, and the support of computer-based IT

systems (Cheng et al. 2008, p. 468). Botta-Genoulaz et al. (2005, p. 515) argue that information technologies do not have an impact for the productivity of an enterprise but instead the way people use these technologies is crucial. If this is not taken into account, information strategies may fail (Botta-Genoulaz et al. 2005, p. 515). Technologies must enable all modern businesses activities. For example, if data has been placed incorrectly to a system, it may be more damaging than beneficial to a company.

Helo & Szekely (2005, p. 7–12) divide the supply chain management (SCM) softwares into four groups: warehouse and transportation management systems (WMS/TMS), enterprise resource planning (ERP) systems, supply chain management software applications, and enterprise application integration softwares. Supply chain management software applications concentrate on improving planning for the future and making timetables for inter-company operations related to the material flow (Kovacs & Paganelli 2003, p. 167–168, cited in Helo & Szekely 2005, p. 11). An enterprise application integration software means that applications inside a company share information among external systems (Helo & Szekely 2005, p. 12).

Theory of an ERP and TMS is discussed below. The ERP and TMS are vital for this thesis because sales orders at DCs are placed and handled in the ERP. In addition, the ERP contains item data and the system is used for invoicing. When the order is ready for loading, the ERP sends messages through enterprise application integration (EAI) service to the TMS. These systems must be integrated to enable transference of data between the systems. Enterprise application integration is integration service enabling delivery of business data between applications.

3.4.1 Enterprise Resource Planning System

An enterprise resource planning (ERP) system can integrate all departments and functions across a company (Somers & Nelson 2001, p. 1). The ERP should be targeted to the needs of the company. The best implementation method is dependent on the size of the enterprise and its industrial sector (Mabert et al. 2003, cited in Botta-Genoulaz et al. 2005, p. 513; Wu & Wang 2003). Aligning the ERP process with the business process is critical phase (Somers & Nelson 2001, p. 4; Botta-Genoulaz 2005, p. 514) and it is often created from a long-term (Botta-Genoulaz 2005, p. 514). ERP implementation can provide a competitive advantage for an organization. It enables changes in relationships, practices, and behaviors. These elements may be an advantage in a knowledge economy. (Botta-Genoulaz et al. 2005, p. 515.) Robinson & Dilts (1999, cited in Somers & Nelson 2001, p. 4) claim that successful ERP implementations mean that there should be only minimal customization. If customization is done, implementation may require more time and increase costs (Somers & Nelson 2001, p. 3). The ERP develops constantly. Because of extensive component systems and integration tools, the supply chain applications of a third party can be linked to the ERP (Stefanou 1999, p. 800). This may help to transfer data between companies.

According to Sarker & Lee (2003, cited in Botta-Genoulaz 2005, p. 514), there are three main factors for success of implementation of systems: capable and devoted leadership, open communication, and an empowered implementation team. Stefanou (1999, p. 802) claims that engagement to team-work, good communication skills, trainings, transformative leadership, and openness lead to information sharing which is vital for successfully harnessing ERP systems. A successful implementation and satisfied end users require usefulness and learnability from ERP systems (Calisir, F. & Calisir, F. 2004, cited in Botta-Genoulaz 2005, p. 514).

Human factors are important when implementing the ERP (Botta-Genoulaz et al. 2005, p. 513). By attending to pre-implementation, it is possible to create positive opinion about ERP systems (Abdinnour-Helm et al. 2003, cited in Botta-Genoulaz et al. 2005, p. 513). It is assumed that this is valid relating to other systems too: if the pre-attitudes are positive, implementation is more successful. Shared assumptions can make implementation smoother and get approval for the system (Kwasi Amoako-Gyampah & Salam 2004, cited in Botta-Genoulaz et al. 2005, p. 513). Luo & Strong (2004, cited in Botta-Genoulaz et al. 2005, p. 513) claim that there should be a method for controlling the tensions both during and after the implementation project. Successful technological innovations are often dependent of a person who achieves transformational leadership, assistance, and marketing the implementation (Beath 1991, cited in Somers & Nelson 2001, p. 2; McKersie & Walton 1991).

Before an implementation, top management has to establish capabilities and limitations as well as goals for IT systems. Management is required to demonstrate commitment to the successful introduction of IT, and ensure that all workers are aware of the company's IT strategies. (McKersie & Walton 1991, cited in Somers & Nelson 2001, p. 2.) ERP systems are used as a managerial tool. They require a diverse consideration of operations management, information systems, finance, marketing, organizational behavior, and human resources. (Sarkis & Sundarraj 2003, cited in Botta-Genoulaz et al. 2005, p. 515.) ERP systems are extended to web-based applications, which may include e-commerce and customer-relationship management (Stedman 1999, cited in Somers & Nelson 2001, p. 1).

ERP systems are combined with other IT technologies (Botta-Genoulaz et al. 2005, p. 517). ERP systems offer a platform for managing core business within a company. This includes, for example, supply chain management (SCM), customer relationship management (CRM), as well as decision-making between marketing and production planning on the supply chain. (Botta-Genoulaz et al. 2005, p. 517.) SCM, CRM, advanced planning systems (APS), business-to-business (B2B), and business-to-consumer (B2C) have been proposed to complement some of the functionalities of ERP systems (Botta-Genoulaz et al. 2005 p. 512–513). The ERP can offer a more efficient supply chain both internally and externally (Bergström & Stehn 2005, cited in Botta-Genoulaz et al. 2005, p. 516).

The aim of a company is to discover ways to reduce costs, increase earnings and productivity. By improving IT systems, companies may find a way to reach these objectives. It is possible that SCM, ERP, and WMS/TMS softwares will be integrated subsequently. Many ERP systems include warehouse and transportation modules. (Helo & Szekely 2005, p. 14–15.) Customers' needs need to be taken into account as well. Helo & Szekely (2005, p. 16) state that companies should understand customers' manners and thus demand management systems may be built for logistics management.

IT systems require real time information from data accuracy to material flow (Helo & Szekely 2005, p. 5, 16). This means that IT systems need to be flexible and they have to be able to handle large amounts of data. In addition, IT systems have to be easy to interconnect. To make this possible, system integrations are needed. Time, expertise and money are needed for the selection of softwares. (Helo & Szekely 2005, p. 5.) Logistics network needs flexible IT systems. IT systems should be interconnectable as well as easily changeable (Helo & Szekely 2005, p. 16). ERP systems as well as traditional information systems require maintenance and upgrading. Maintenance activity is one optimization perspective. (Botta-Genoulaz et al. 2005, p. 514.) Companies can keep their competitive advantage if they apply their IT constantly (Cheng et al. 2008, p. 466).

Guidance, communication, or a role of the executive team are not always taken into account when implementing systems. Conflicts are common during the implementation phase. (Botta-Genoulaz et al. 2005, p. 513.) Updating and maintenance of systems do not always proceed as well as they should. In addition, updating, maintenance, and development are often expensive and slow.

3.4.2 Transportation Management System

There are various transportation management systems (TMS). Metso's system has been built to meet the company's requirements and can be adapted to continuously changed business requirements. Transportation management system may, for example, be a way to plan how shipments would be good to pick up and deliver so that costs would be reduced (Jauffred et al. 2005, p. 1).

Transportation management may also refer to real-time controlling and planning on how to load vehicles, track vehicles, plan routes and coordinate fleets of vehicles (Karhunen et al. 2004, p. 24). Metso is focusing to load and route planning, the other areas are Metso's 3PL responsibility to carry out as optimum way as possible based on the Metso's agreement with 3PL suppliers. Information of the order is sent from MTG to all parties involved by using different kind of message formats. All necessary information for the booking is automatically available for all parties.

3.4.3 Systems Integration

It is essential that all the systems discuss together, both inside a company and between the company and stakeholder organizations. It is critical to integrate information and synchronize data to ensure its smooth flow and make sharing information possible in the whole supply chain (Evgeniou 2002, cited in Stefansson & Lumsden 2008, p. 58). For example, at Metso ERPs and TMS are integrated. Part of the data which is entered into SAP passes to MTG through EAI. Many of the fields in SAP are linked to equivalent fields in MTG. Some data, like tracking number and freight cost, may be returned from MTG to SAP. In addition, TMS and a forwarder's systems are integrated as well.

Several business transactions between companies require information flow, such as orders, invoices, shipment notices, and billing. Organizations use paper documents for these transactions, even though handling and sending paper documents is slow, prone to errors, and labor intensive. Subsequently, EDI has become a more common form to transfer electronic information of orders, invoices, shipping, and billing between organizations. (Premkumar et al. 1994, p. 158.) Mukhopadhyay et al. (1995, p. 138) claim that EDI can change the way how companies operate with customers and suppliers by developing the accuracy and timeliness of information which is transferred manually. Also Premkumar et al. (1994, p. 158) see that EDI has changed fulfilment methods of inter-organizational transactions. Reduced costs, faster turnaround, and better customer service can be achieved by using EDI (Premkumar et al. 1994, p. 158).

Currently, web services and cloud computing could be used, for example, for sharing information between systems. According to Alonso et al. (2004, p. 124), web services are component parts which are integrated into more complex distributed applications. A definition of a web service according to Snell et al. (2002, p. 1) is "a network accessible interface to application functionality, built using standard Internet technologies".

Cloud computing are the applications delivered as services over the internet and the hardware and systems software. This acts in the data centers that provide earlier mentioned services. (Armbrust et al. 2010, p. 50.) Companies may reduce costs by using cloud computing infrastructures (Santos et al. 2009, p. 1). According to Amazon Web Services (2016), the major benefit of cloud computing is that it enables to replace initial capital infrastructure costs with lower costs based on the business. IT infrastructure is not needed to plan months in advance (Amazon Web Services 2016).

4. METSO AND THE ORDER-TO-DELIVERY PROCESS AT METSO MINERALS

The purpose of this thesis is to develop the order-to-delivery process of selected distribution centers (DC) of Metso Minerals. This thesis concentrates on distribution centers and sales and service offices (SSO) in Europe. The following units are handled in more detail:

- DC Europe (DCE),
- DC Trelleborg,
- DC/MRE Düsseldorf,
- DC/SSO Mâcon,
- SSO in the United Kingdom and
- Domestic Sales in Finland.

In general, distribution centers deal with wear and spare parts for crushers. Crushers are machines which reduce large rocks into smaller parts. MRE concentrates on metal recycling business. DCs ensure the availability and reliability of the parts, as well as their fast deliveries to customers. DCs' customers are principally distributors or Metso's other units: SSOs or DCs. DCs' customers, like SSOs, sell their products to end customers. For the most part, DCs operate with their customers, suppliers, factories, warehouses, and forwarders but not with end customers.

Empirical part of the thesis starts by presenting the subscriber of this research and building a picture of the current order-to-delivery process in the selected units of the company. The process of DC Europe is described detailed in Section 4.3. Processes of DC Trelleborg, MRE Düsseldorf, DC/SSO Mâcon, SSO Rugby and Domestic Sales in Finland are described individually in Sections 4.4–4.8. The process is covered from the purchase order to a supplier and inbound logistics to the delivery to a customer. Section 4.9 presents differences and similarities of the order-to-delivery process between the above mentioned locations. Challenges of the units are presented in Chapter 5.

The author of this thesis bases the views of the processes on observing the various teams' working and own experience as logistics coordinator at DCE. In order to be able to form appropriate interview questions, it is crucial that the interviewer understands the process well. In addition, certain questions need to be targeted to the right persons. The interviews clarified certain details of the process. Understanding the current state of the process is crucial for its future development. The main focus of this thesis is on the current state of the order-to-delivery process.

4.1 Presentation of Metso

Metso is a listed industrial company in the mining and aggregates industries and in the flow control business. It is world's leading industrial company in its own business area with process knowledge and a huge range of services, including almost a hundred service centers around the world and a wide logistics network. (Metso 2015a.) The corporation serves the customers mostly in the mining, aggregates, recycling, oil, gas, pulp, paper, and process industries globally. Customers can improve their efficiency, reduce risks, and increase profitability through Metso's know-how, experts, and innovative solutions. (Metso 2015b.) In 2015, Metso's net sales totaled circa EUR 2,9 billion; services business formed 63% of this amount. Metso employs over 12 000 people in more than 50 countries. Figure 4.1.1. illustrates where Metso operates. (Metso Oyj 2015, p. 4.) Colors demonstrate Metso's different market areas. Metso has over a hundred years of history.

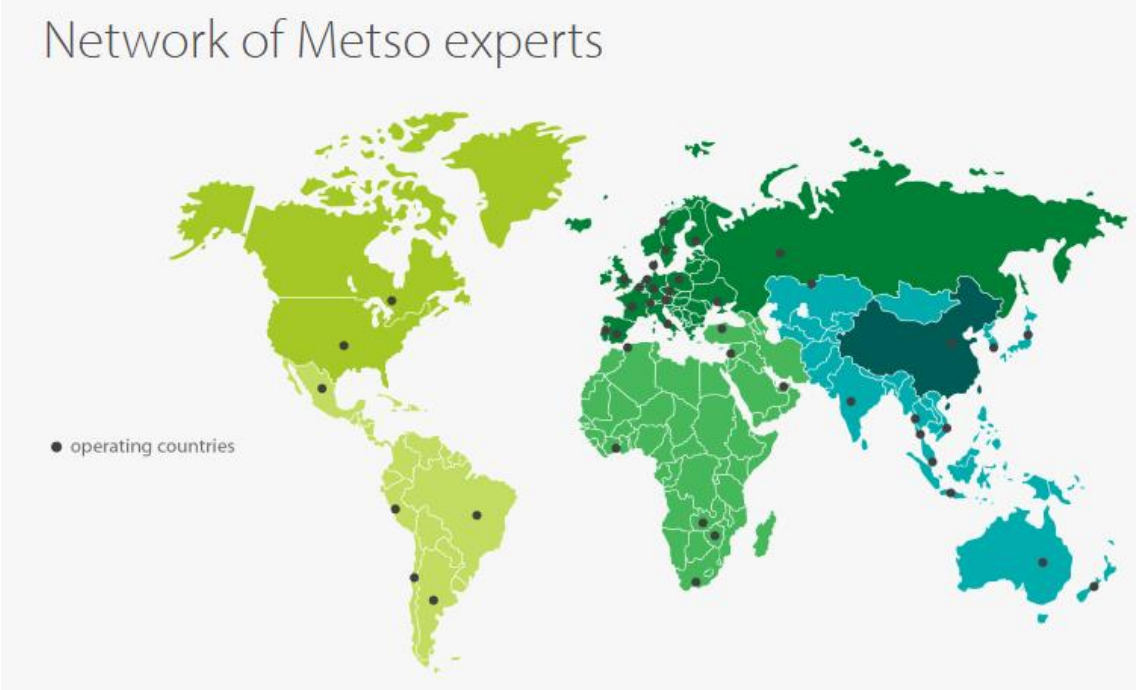


Figure 4.1.1. *Operating countries of Metso (Metso 2015a).*

Metso's products are mining and construction equipment and systems to industrial valves and controls. In addition, Metso offers systems, projects, and services business. (Metso 2015a.) According to Metso Oyj (2015, p. 26–27), the minerals segment is divided to two business sectors: Minerals Capital (large projects and machines) and Minerals Services (spare parts and wear parts). Minerals Capital provides minerals processing solutions and system deliveries for mining customers and crushing and screening products for aggregates customers, whereas Minerals Services provides spare and wear parts and high-value adding services for both of these customer segments. Flow Control business offers valves for customers who deal with oil and gas, and pumps for customers in mining business

sector. (Metso Oyj 2015, p. 26–27.) This thesis will not discuss Flow Control. Figure 4.1.2. presents how Metso operates.

Figure 4.1.2. *Metso's operating model (Metso Oyj 2015, p. 4).*

Metso is a customer-oriented organization (Metso Oyj 2015, p. 12). According to Metso Oyj (2015, p. 7), the mission is "to contribute to a more sustainable world by helping our customers to process natural resources and recycle materials into valuable products". Metso's values are related to its mission: "driving customer success, seeking innovations, performing together, and respecting each other. These values guide us in how we do business and how we work together with internal and external stakeholders." (Metso Oyj 2015, p. 7.) Safety at work is number one priority for Metso (Metso Oyj 2015, p. 4).

Megatrends such as globalizing economy, sustainability and climate change, urbanization, and emerging markets growth guide the demand for Metso's products, services and solutions (Metso Oyj 2015, p. 8). Following tables present Metso's net sales from three perspectives. Table 4.1.1. presents Metso's three business areas and their net sales compared to each other. Net sales of Minerals Services is nearly half of the total net sales of Metso.

Table 4.1.1. *Net sales by business area (Metso Oyj 2015, p. 9).*

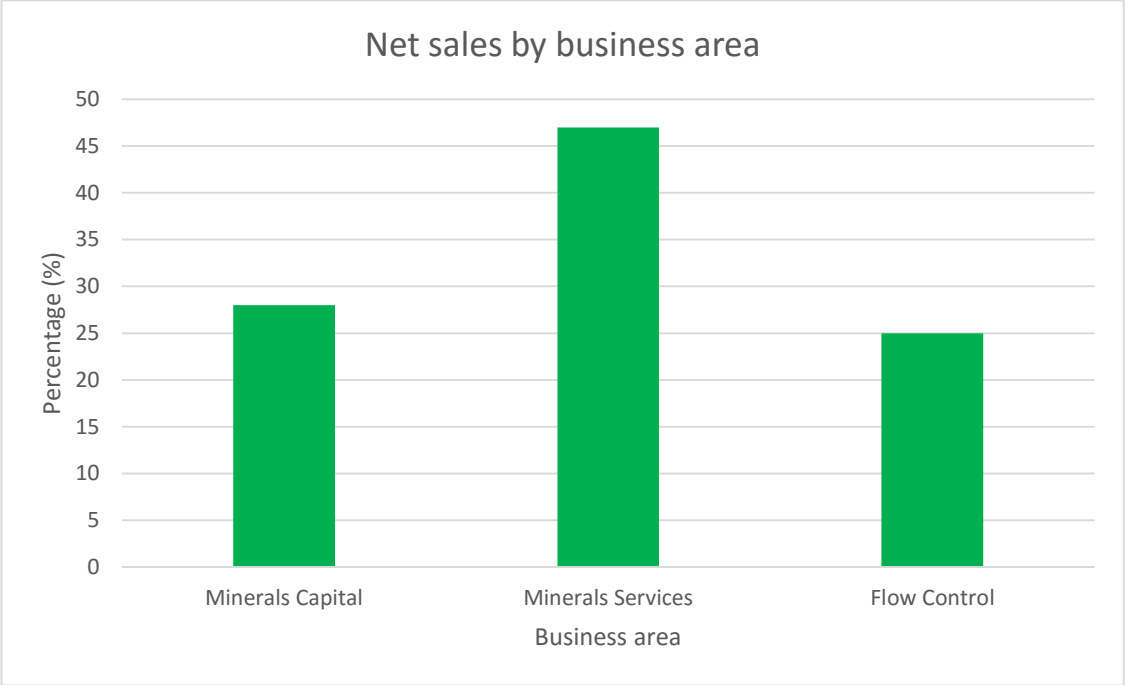


Table 4.1.2. instead presents net sales by market area. The highest sales are to Europe and the second to Americas. China is its own market area with about 7% of net sales.

Table 4.1.2. *Net sales by market area (Metso Oyj 2015, p. 5).*

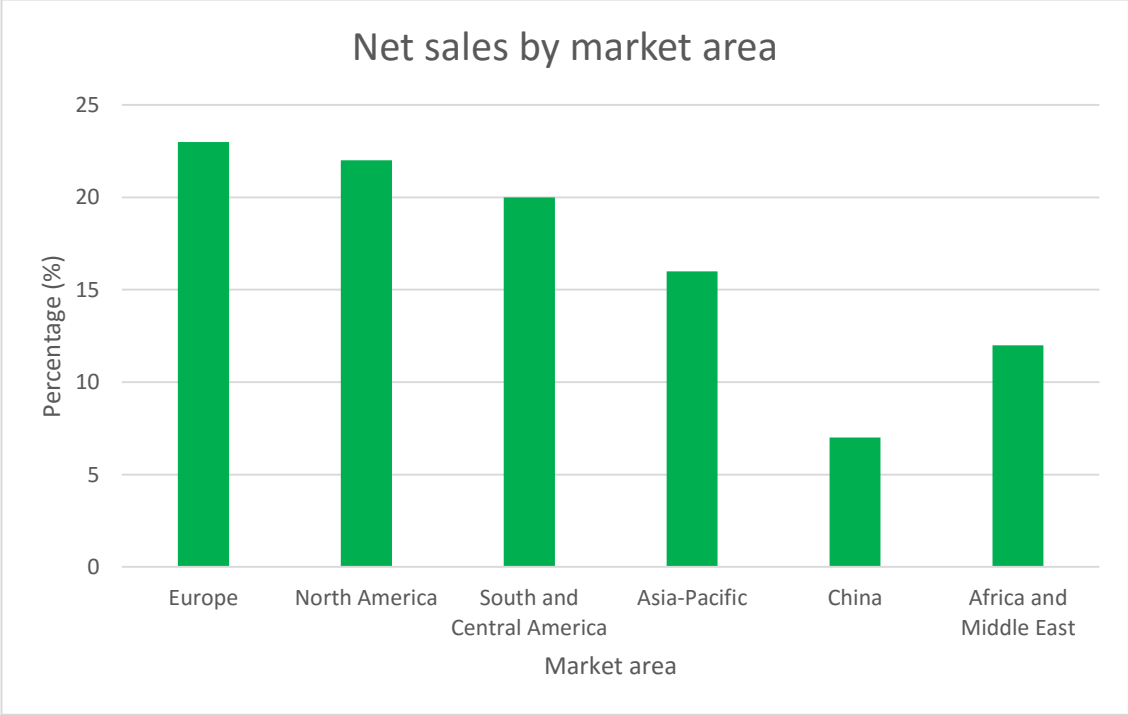
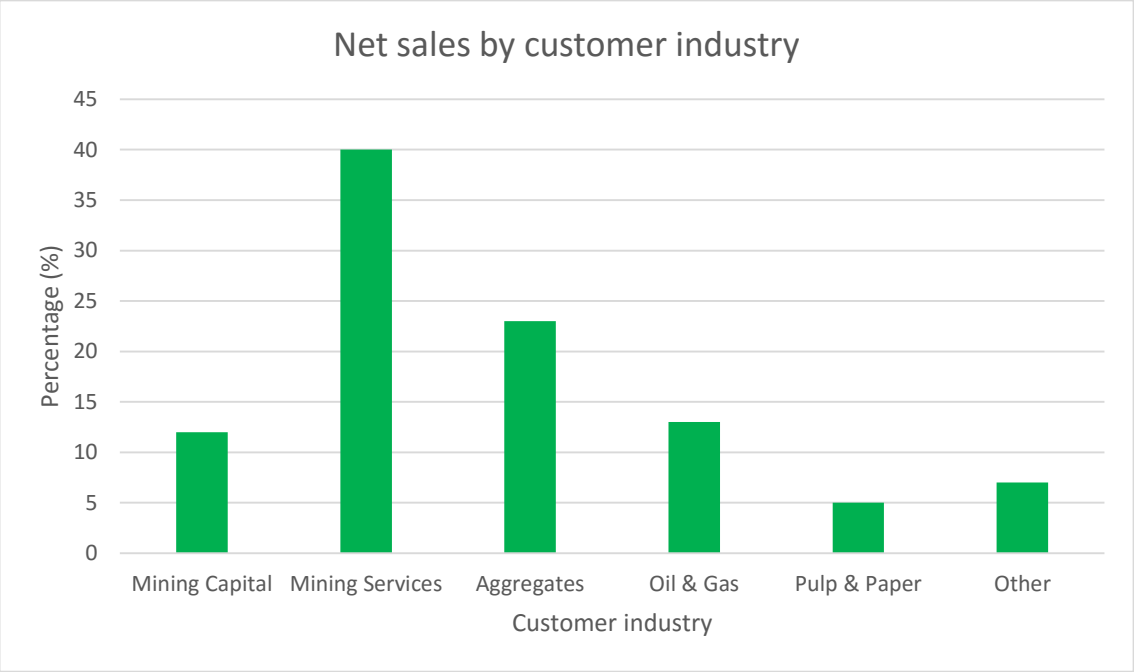


Table 4.1.3. presents net sales by customer industry. Mining Services stands out 40% net sales. Aggregates is another clearly distinguishable customer industry.

Table 4.1.3. *Net sales by customer industry (Metso Oyj 2015, p. 5).*



Metso has 12 Distribution Centers (DC) which are a part of Metso´s Service Business Line. DCs are located all over the world and they handle with wear and spare parts service for crushing and screening solutions. DCs have departments of customer service and order entry, item opening and product support, inventories management, planning and procurement, logistics, and warehouse operations. Warehouse locations of European DCs are in Tampere, Finland; Trelleborg, Sweden; Gällivare, Sweden; Oslo, Norway; Prerov, Czech; Born, the Netherlands; Rugby, the United Kingdom; Mâcon, France; and Madrid, Spain. European DCs are located in Finland, Sweden, Mâcon, Prerov, and Russia & CIS. Of the 12 DCs, DC Europe (DCE) in Finland is the largest, followed by Columbia in South Carolina, United States. The third largest is Sorocaba in Brazil, and the fourth is Trelleborg in Sweden.

Transportation plays a key role at Metso. There are nominated forwarders for almost every transportation mode from almost every location to almost every destination. Despite nominations, and within the terms of contracts between Metso and forwarders, the order handler can decide a mode of transportation. If necessary, the handler or logistics coordinator can also choose a forwarder outside the nomination. This thesis focuses on how transportation decisions are made in the investigated locations. However, the whole order-to-delivery process is taken into consideration.

4.2 Order-to-Delivery Process at Metso Minerals

DCs' customers are principally Metso SSOs, DCs or distributors. SSOs and distributors sell products to end customers. DCs' customers order mainly via email, a web-based ordering system, or by placing an order directly into SAP. Distributors mostly use the first two options and Metso sales and service offices use the first or third option. The customer can propose or decide a forwarder and/or a mode of transportation for the delivery. The choice may not be the most rational. If a customer service representative places the order into SAP on the customer's behalf, there generally are fewer mistakes than when the customer places the order. If the customer does not make an order to SAP itself, the customer service representative checks the purchase order and can suggest a better way to deliver it. When the order is entered into SAP, the warehouse, according to the placed plant in SAP, receives the order details via SAP. Material is either available in stock, or it is purchased based on the new order.

The warehouse starts to pick and pack orders in the correct order according to the dates and times in SAP. The dates depend on the transportation service, destination, and order priority. Customers' order priority types are breakdown, express, and standard. When the order has been packed and packing details, such as weight and dimensions have been placed into SAP, a shipment will be created either manually or automatically – depending on the DC. When the shipment is formed in SAP, the booking often progresses to MTG. This depends on a forwarder because systems of all Metso's forwarders are not integrated with MTG. If the forwarder's system is not integrated with MTG, the booking must be created manually which usually means an email. However, many third party service providers receive transportation orders via MTG. Forwarders pick up shipments according to agreed schedules.

The key systems in the order-to-delivery process at Metso Minerals are enterprise resource planning system (SAP), transportation and packaging managing system (MTG), and purchase order management system (Pool4Tool, P4T). Other relevant systems are product data management system, warehouse management system, monitoring tools, invoice processing system, other booking systems, forwarders' web portals, forwarders' webpages, customer feedback database, export declaration system, order reporting system and certain information databases.

Purchase orders (PO) in inbound are always made in SAP. There are following ways to deliver the POs to suppliers: either by electronical transfer by using P4T system or by email. If the supplier of the material uses P4T, SAP sends data through integration service to P4T. If the supplier does not use P4T, the procurement team sends the PO by email to the supplier. The supplier can open a purchase order (PO) and attachments in P4T and confirm PO delivery date. If delivery date suits the purchase team, the purchaser accepts the confirmation. If it does not suit, the supplier has to re-confirm the PO until the purchaser accepts it. Certain information from P4T is transferred back to SAP.

A sales orders is placed into SAP which generates a delivery for which is created a shipment either automatically or manually in SAP. After that, the shipment data is send from SAP through EAI to MTG. SAP should contain all the required data regarding an order, otherwise the order will stop in MTG and a booking will not be send to the transportation or packaging suppliers. In addition, after the delivery creation in SAP, SAP sends picking and packing information to the warehouse management system and when the goods have been picked and packed, the system sends packaging details back to SAP. Thus, the shipment can be generated in SAP.

MTG is a transportation and packaging management system built to Metso's specifications. MTG is a gateway between business systems of Metso and transportation and packaging suppliers. As MTG is the transportation management system, the aim is to have all inbound and outbound transportation related information there. MTG offers, among other things, freight calculation, booking, tracking, automatic consolidation and package management. Nearly all forwarders return a status of the delivery to MTG which means that most of the deliveries can be monitored from a single place. Both inbound and outbound bookings can be created in MTG.

MTG communicates with transportation and packaging suppliers during the shipment delivery process and can send all the required information back to SAP. DCs have agreed certain data elements, such as the tracking number, to be received back from MTG to SAP. Data is transferred between SAP and MTG so that SAP sends iDoc messages to EAI Service which converts them UBL Waybill format and sends forward to MTG. In turn, MTG sends UBL Waybill messages to EAI service which converts them to iDoc format when they return to SAP.

The order-to-delivery process in Figures 4.2.1. and 4.2.2. is simplified. The process is drawn so that it is valid in all locations where interviews have been organized. More detailed processes are discussed below from Sections 4.3 to 4.8.

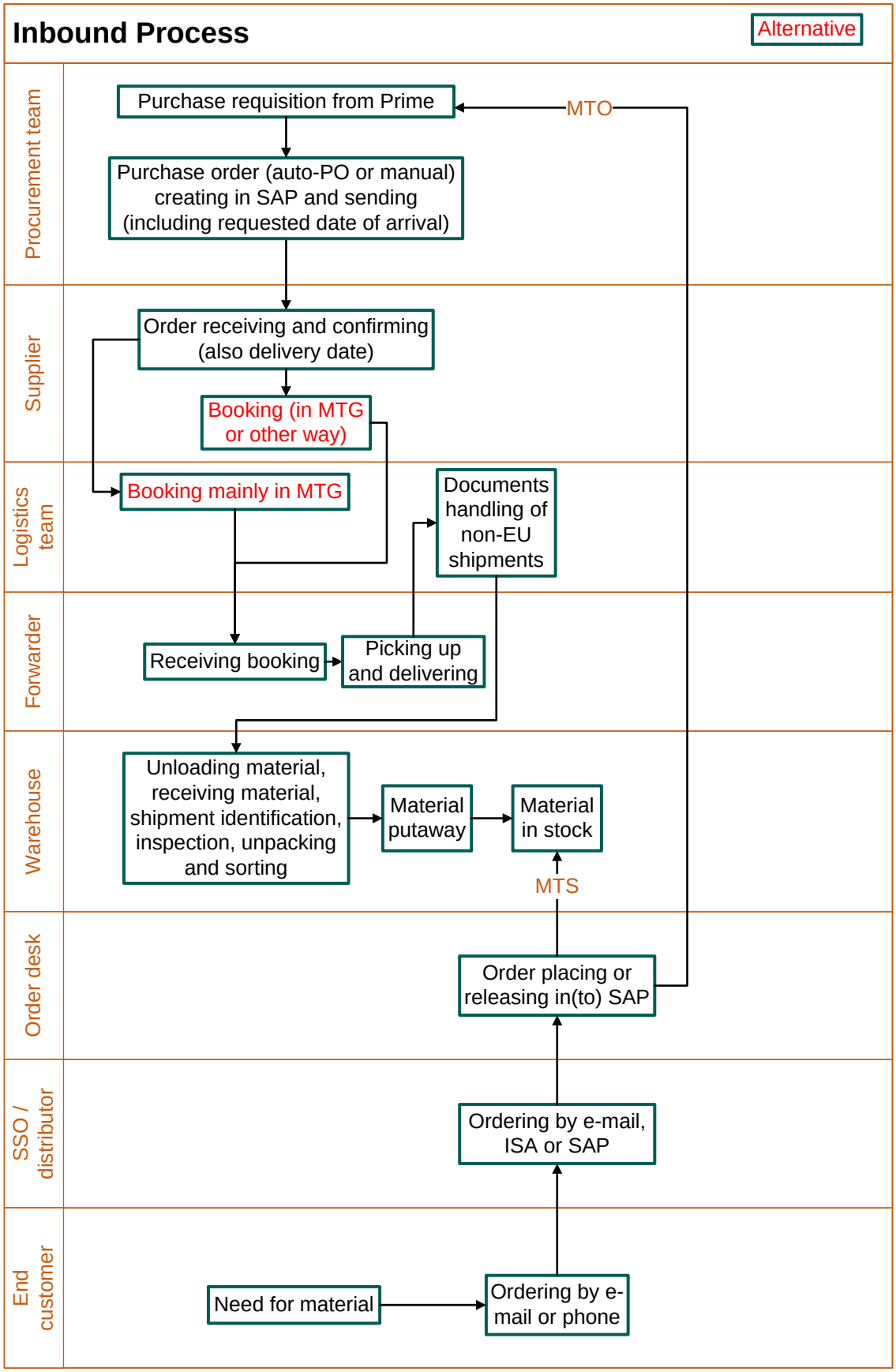


Figure 4.2.1. *Inbound in the order-to-delivery process.*

Red color means that the phases are alternatives to each other. In inbound process, either the supplier or the logistics coordinator makes the booking to a forwarder either in MTG or by other means.

In outbound process, it depends on Metso Minerals' unit if a forwarder is chosen during an ordering step. It can be selected during a shipment creation as well. Post goods issues (PGI) are created differently and in different phases in individual units.

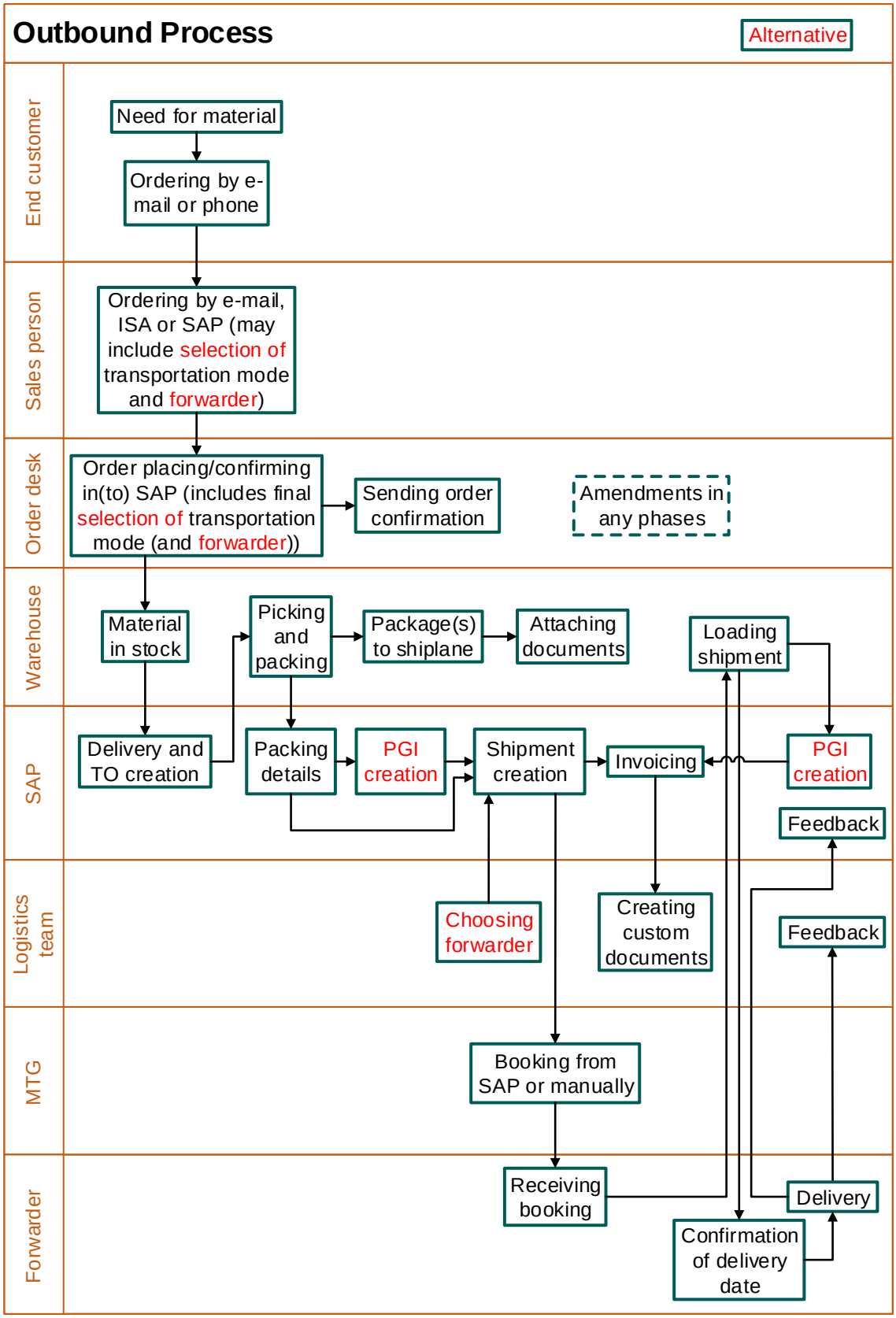


Figure 4.2.2. *Outbound in the order-to-delivery process.*

In this thesis, the order-to-delivery process is limited: it starts from the customer order and ends with the delivery to the customer. This allows the customer oriented approach.

Companies would like to produce everything what and when customers wish (Holweg & Pil 2001, p. 74) but unfortunately it is not always possible. The order-to-delivery process is a single entity although it can be divided to parts. Everything is related to everything: if some material arrives late from a supplier, later stages must be accelerated or orders will be delayed.

4.3 Order-to-Delivery Process at DC Europe

The office of Distribution Center Europe (DCE) is located in Tampere, Finland, and there are working almost 50 people in it, excluding the warehouse personnel consisting of approximately 30 people. The warehouses of DCE are located in Tampere and Born, the Netherlands. The warehouse in Tampere deals with approximately 10% of DCE's volume and the warehouse in the Netherlands nearly 90%. There are six teams in DCE: procurement, item management, product support, order desk, logistics, and development. In addition, there are both outsourced and own warehouses, which have their own teams. The central warehouse in Born is outsourced. Figure 4.3.1. presents operations of DCE.

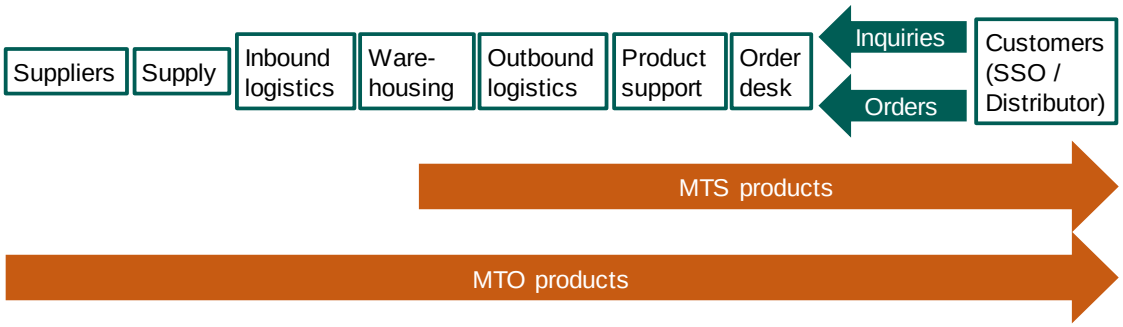


Figure 4.3.1. *DCE operations and functions.*

Based on the delivery data in SAP from January to March 2016, the following conclusions can be made. The customers of DCE are mainly located in Europe, Middle East and Africa. Manual orders which mean purchase and sales orders (PO/SO) are mainly from non-EU countries. The order types (ICSO, ICPO, PO/SO or ISA) are covered in Sections 4.3.2. and 4.3.3.

Metso has customers all over the world. An order can be delivered to a DC's direct customer which means a SSO or distributor. At times, the order is delivered directly to an end customer even if the cash flow goes through a middleman.

Metso has a plenty of data from its orders and deliveries. In this thesis, the data is mainly used to support the interviews. The cost of a single item, item group or total cost of a warehouse should be monitored continuously (Karrus 198, p. 137). DCs measure costs per order line.

The following sections discuss the basic order-to-delivery process from DCE's point of view. Order and delivery processes have been divided in four parts at DC Europe. These consist of inbound order process, inbound delivery process, outbound order process, and outbound delivery process. Warehouse processes are included in inbound and outbound delivery processes. The orders can be monitored in all stages of the processes. The monitoring is important because several phases of the order-to-delivery process at DCE are automatized and transparency may be impaired. Exceptions will not be taken into account in this description but will be handled in Chapter 5 on the basis of the interviews. The process descriptions below are based on available documents and instructions, interviews, internal conversations, observation, and the researcher's own experiences as logistics coordinator at Metso Minerals. DCE's operations will be handled in Sections 4.3.1–4.3.6.

4.3.1 Item Opening and Product Support

An item is a goods category which forms its own controlled entity. A unique identifier is defined for this category. (Karrus 1998, p. 308.) Metso Minerals has thousands of items in its own product catalog. Metso Minerals produces wear parts which are used for crushing. In addition, the company produces specific parts for customers' needs. Spare parts are purchased mostly from external suppliers. Several Metso Minerals locations are responsible for one or more crushing machines. Producing a wear part is not dependent on the location where the machine, for which the part is produced, is made.

Each item has a default supplier which is nominated by item opening team when an item is opened in a system. Suppliers may be either internal or external. The product support team helps customers in technical matters and informs of the availability of parts. Metso Minerals has a product data management system where the data of materials, both pictures and master data, are maintained.

4.3.2 Procurement and Inbound Logistics

Metso Minerals has several external suppliers around the world from whom DCE's procurement team purchases material. It is also possible to buy goods from internal suppliers: other Metso units, factories and DCs. Purchase orders are created either on the basis of a sales order or a replenishment of stock. Stock transfer orders (STO) are transfers between own warehouses or production.

Internal partners for procurement are production, material operations and sales (Karrus 1998, p. 205). The main tasks of a purchase team are monitoring reliability of suppliers, ordering, solving operational discrepancy report (ODR) cases, solving where missing shipments are, amending orders, and answering for technical questions. The warehouse tells by using an ODR that something is wrong with the order. The ODR may be, for example, a result of a credit block of a delivery. The purchase team monitors their purchase orders until the material is available in a warehouse.

In the inbound order process, DCE and other DCs, have an automatic system which shows if a material availability is low and the material should be ordered. These purchase and balancing requisitions appear mainly from Prime which has been discussed above in Section 3.1.2. The purchase team mainly validates those requisitions. At times purchase orders are placed without purchase requisition, for instance in breakdown cases.

There are four order types: purchase order (PO), inter-company purchase order (ICPO), stock transfer order (STO) and third party direct delivery. POs are created either automatically (auto-PO) or manually. Balancing orders and STOs have not auto-PO possibility so purchasers make those orders manually. When the order is created in SAP, it is sent to a supplier by using Pool4Tool (P4T). If a supplier does not use P4T, POs are sent by email. Purchaser sees a standard lead time for each material from SAP. If a lead time is not satisfactory, purchaser can ask for better lead time from a supplier. Every item has its own default supplier, but in special cases an item can be purchased from some other supplier. Delivery dates in Pool4Tool are same as in a purchase requisition. Lead time, delivery time, and date are calculated in SAP according to certain material and shipping date. If a supplier has two shipping dates per week, SAP can choose one of those two. The supplier confirms the order in Pool4Tool or by email. If the supplier is not able to supply the material by the requested delivery date or there are some other alterations, the supplier sends a counter-proposal to a purchaser. This information comes from P4T to email box automatically. The purchaser checks the lead time, price, incoterm, and quantity and confirms the counter-proposal if it is acceptable. If the supplier uses P4T, it confirms the order there and this information goes through into SAP. If the supplier does not use P4T, it sends information by email and a purchaser complete information into SAP. In case of internal orders, STO or ICPO, an order is sent to a supplier but a separate confirmation is not needed. The confirmation is created automatically when the order is saved in a system. In third party deliveries, a supplier receives a PO and sends an order to a customer.

Purchase team handles also balancing and return shipments. Purchasers take care of balancing orders in warehouses. If the inventory turnover in a warehouse is fast and another warehouse has excess, the inventories will be balanced. Balancing may also happen if a supplier supplies all material solely to the Born warehouse and they do not supply to Tampere. Then Metso Minerals can arrange a delivery from Born to Tampere. Returning shipments from customers are checked case by case. The turnaround, safety stock, open orders for the material and recent sales all affect the possibility to return the shipment.

The inbound delivery process is located mainly at warehouses. Usually, suppliers book a delivery for Metso Minerals. If the supplier makes a booking in MTG, the purchaser can get a notification from MTG by email, and monitoring the delivery is easier. It is desirable because it enables the purchaser to see the booking details for the orders from a single place. There are prepared templates for suppliers in MTG so it is easier to make bookings there. The supplier only needs to fill the handling unit data in order to book an order. It is

crucial that the delivery address is correct when the supplier makes the booking. Other detailed information, such as the building, must be correct. In turn, the recipient must be careful about what to receive.

There is a default mode of transportation and forwarder behind a supplier data in SAP. This forwarder goes through to every order. However, this forwarder is not always the best possible for each order, so the supplier can change a forwarder for each shipment if it is reasonable. An incoterm comes behind the supplier as well. The purchasers have instructed suppliers what forwarders are good to be used for what kind of orders. They should not always use the default forwarder. The purchaser can change the forwarder for an order. The purchasers cannot say when the order will be shipped from a supplier, which means that they do not know if there is a single order or several orders to be shipped within a day. Because of this, the purchaser does not choose the forwarder for an order immediately. Instead, the supplier knows how many orders are shipped on a certain day to Metso Minerals, and what is total weight and dimensions of the orders. Suppliers are able to tell the best forwarder for each shipment. If the default forwarder is a truck company, but the only order shipped on a given day weighs only 5 kilograms, it is more reasonable to ship it by courier. In this case, the supplier should book the order for the courier according to the manual it has received from Metso Minerals – even if a truck company is set as default. In case of breakdown order, the purchaser asks for the best possible lead time for an order and the order can be shipped by courier even if the order were heavy. All suppliers do not use the manual and at times the orders are shipped ineffectively.

The inbound logistics coordinator takes care of inbound logistics. Sometimes the process is quite automatic and forwarding agents supply material to a warehouse without any information about an arrival, whereas at times they have informed logistics coordinator when the material will arrive to the warehouse. The inbound logistics coordinator receives more information about shipments from outside the European Union than from the EU. The logistics coordinator may inform a warehouse about the goods what they will receive but mainly they just receive goods without any information.

The supplier makes a delivery note which means that the supplier has shipped the order. The supplier should also inform when the order will arrive. If a supplier has not filled a delivery time in Pool4Tool, the warehouse cannot receive an order in systems. In these cases, the warehouse and purchaser have to make corrections together. The supplier should create an advanced shipping notification (ASN) in P4T and on the actual dispatch date send the delivery note to SAP. The ASN includes a packing list created in P4T so it has Metso Minerals' layout and it is easier for a warehouse to receive a package. When the supplier has confirmed the delivery date, the information passes to SAP. If there are some changes in the order, for example, if the order will be shipped late or before the planned time, suppliers confirm amendments in P4T web portal. The delivery note cannot be sent if the supplier does not use P4T. Unfortunately, all suppliers do not provide any information even if an order is late. If the material is not available when it should be, it is

possible that the whole chain suffers and the order to the customer is delayed. Teams may follow open orders from Every Angle (EA) report. Every Angle is a business analytics solution linked to SAP (Every Angle Software 2016). Procurement and order desk teams can see if purchase orders or sales orders are late or might be late. The purchase team monitors also reliability of suppliers.

The goods can be received using different references, for example PO number, delivery number or sequential number from P4T. There are differences between suppliers in the kinds of labels they use in packages. When material arrives to the warehouse, the personnel open the packages and unload the goods to a correct shipping lane. Each material is checked separately with regard to a material code and name, country of origin, and quantity. The warehouse receives the goods, marks when the goods have arrived, checks the order visually, and marks down any mistakes and deficiencies with the order. The warehouse makes inspection for the goods and checks that all ordered parts have arrived. If some material is, for example, broken or missing, the warehouse makes an ODR for the purchase team and the team solves a problem usually with the supplier. Broken packages, rusty parts and returning shipments are checked more precisely than normally. In ODR cases material has to be put a block so that Metso Minerals will not sell material which does not actually exist or which cannot be sold. If everything is in order, a sticker is printed and placed on the material. The sticker tells the material code and name, country of origin, PO reference, and batch. Scanners are used for the checking, but they need a reference to work. If a warehouse's personnel do not know to which order material belongs to, they can obtain more information referring to material and purchase orders from SAP and compare those with arriving goods.

After the first phase, goods receival can be done in SAP. This means that the goods are received into the warehouse but the material is not available for customer's orders yet. After that the warehouse creates a transfer order (TO) for each material in SAP. The transfer order contains information required to execute the physical transfer of materials into or out of the warehouse or from one storage bin to another within the warehouse (SAP 2016). Metso Minerals uses the term putaway for the situation when the material is in the correct stock place and can be collected for a customer's order. Putting away happens either by using batches or material and PO numbers. A scanner shows the correct stock location. During a putaway, the scanner reads the barcode from the material sticker. Then the scanner tells the batch, material, quantity and a stock place for each material. Warehouse personnel compare data of the scanner to the physical material, and put the material into stock. If there is not a place for that particular material, the scanner informs about it as well. It is possible to change a proposed stock place. The most important thing is that a material is in a location where is has been marked to be.

4.3.3 Sales and Order Desk

There are four main ways to order material from DCE for customers. Order can be placed by a customer service representative from order desk team in DCE or a customer. The order desk team receives purchase orders (PO) and makes sales orders (SO), whereas customers make either inter-company sales orders (ICSO) in SAP, inter-company purchase orders (ICPO) in SAP, or internet sales (ISA) orders via a web portal.

The purchase order (PO) process starts when an end customer sends a purchase order to Metso sales and service office or a distributor. Next, the sales and service office or distributor makes a purchase order to DCE. The purchase order can be made by email or via ISA. Metso locations sends a PO with SAP form. Distributors who do not use ISA, send the order by an email. The customer often suggests a forwarder and a transportation mode for the order. Some customers are aware of the most reasonable way to deliver an order. They have received a manual for choosing a forwarder and if a subscriber is experienced, the selected forwarder is mainly correct.

Material is the reason for placing the order. The material code and quantity are placed into SAP according to the customer's PO. If the price is available, it is automatically retrieved from the price list; otherwise the parts support team checks the prices. A currency depends on the customer contract. SAP tells if the material is available and if it is not available, SAP tells a date when the material will be available. In this context partial or complete delivery are under selection as well. This means that the customer can choose if all the parts should be delivered together, or if certain parts can be shipped separately from the rest. It is possible to check from SAP if the purchaser has ordered the material, or if the purchase requisition has been placed.

When making an order a sold-to party ID is placed into SAP. There are a ship-to party, customer contact, and forwarder fields with default options behind every sold-to party ID. Each forwarder and their different services have their own IDs. If the default is not correct for this particular order, another ID can be placed. If there is, for example, only one option for a forwarder behind the sold-to party, it comes directly to the order. There are instructions for each country how a forwarder should be chosen. It is told after two paragraphs. The shipping date depends on an availability of material. Normally the shipping date is as soon as possible. There is a lot of variety of incoterms in DCE, so it is important to check that the incoterm is correct. Certain payment details are placed also, such as a payer party. It needs to be chosen too where to an invoice are directed. A forwarding agent and ship-to address are information regarding the delivery on an order. Besides an incoterm, special processing ID influences the payment of freight as well. Special processing ID is a SAP concept and it defines who pays freight. Freight costs will be handled in Chapter 5.8. It is also possible to write free text for an order. There are special fields in the order, such as shipping instructions, markings, internal notes and

printed on invoice. In addition, several attachments can be placed on an order in SAP. Standard attachments include an order confirmation, a purchase order and an invoice.

The customer service representative confirms the order and sends a sales order confirmation to the customer. An order confirmation is often sent automatically to the customer, or the customer is able to check it from SAP. If a customer is not satisfied, for example, with the dispatch date, the order can be returned to the order desk team. However, some of the customers are aware of availability of material beforehand. They have lists where to check an availability. The order desk team can follow material availability date in SAP. It refers to the date when the material needs to be available so that the order can be shipped on the planned date. The transportation planning date is mentioned on the order as well. It means the date when the order is shipped.

For the purposes of this thesis, the choice of transportation mode and, following that, the forwarder when the order is entered into SAP is vital importance. The person who places an order into SAP makes the final decision concerning the forwarder and the mode of transportation. In this thesis, the aim of the interviews was to discover the present status of deliveries, and how the forwarder and the mode of transportation are selected. Another issue is to determine who decides on the mode of transportation and the forwarder for an order. Customers suggest often a mode of transportation for orders. Sometimes customers do not have special needs, which means that the person who enters the order makes the decision. Customers have received instructions on how to choose the mode of transportation. In the case of standard order, there are breakpoints of weight between air and courier, as well as air and ocean, and road and courier shipments. In addition, there are some breakpoints for courier express and economy services. The breakpoint means weight limit: if a shipment weighs more than a certain number of kilograms, it is shipped on one mode of transportation, for example by truck, but if it weighs less, the mode of transportation is different, for example a courier. The following examples could be the breakpoints for European countries:

- 0–10 kg → courier express
- 10–70 kg → courier economy
- 70+ kg → road.

For export countries breakpoints could be:

- 0–20 kg → courier express
- 20–40 kg → courier economy
- 40–200 kg → air
- 200+ kg → ocean.

The breakpoints mentioned above are merely examples. The breakpoints depend on the origin and destination counties – or the areas within a country. The customer service representative or the customer who enters an order must evaluate the correct mode of transportation. They are not able to see gross weight when placing an order because of the numerous ways to pack the order. It is possible to change a mode of transportation and a forwarder later, but it requires monitoring and manual work. A challenge is that SAP consolidates shipments if more than one order is going to same ship-to address and a shipment is formed at the same time. Those orders are booked to a forwarder under a single booking reference, and the total weight of all orders determines the freight costs. This means that it is not always desirable to place a 5 kg order to courier. If there are several 5 kg orders for courier, it would be more cost-effective to deliver the orders via road or air. On the other hand, if the total net weight of items in one order is considerable, transportation by road may not always be the correct mode. Several deliveries may be formed regarding to one order, and a single delivery may weigh only a few kilograms. If all the materials are not available at the same time, the order may not be sent as complete. Then it is possible that the post-delivery may be sent solely by a truck which is not cost-effective. In comparison, courier service would be cheaper and faster for such a small package.

In DCE, the order desk chooses the mode of transportation as well as the forwarder for manually entered SOs. Often customers have proposed a certain forwarder during ordering. First, the best mode of transportation relating to weight and delivery priority is checked. After that the nominated forwarder is chosen. Metso uses nominated forwarders which means that there are contracts between Metso and forwarders for almost each lane from departure country to destination country. If the nominated forwarder is not fast enough, the logistics team starts the search for a special transportation. The incoterm and the payer of freight also influence the selection of the mode of transportation and the forwarder.

An important date in the outbound order process is the delivery date of sales order requested by the customer. This is the first possible date for dispatching the order. It is also important to know when material is available for the order. This will be known before the sales order is confirmed. A route is also defined in SAP when the sales order is placed. The route gives information on the picking and packing time, mode of transportation, transportation planning time, and loading time. The route schedule defines a departure day for the order. Time limits which depend on a route are shown in Figure 4.3.3.1. Picking and packing time depend on the delivery priority. Transportation planning time tells when packaging should be done; it depends on a forwarder placed for the order. Loading time refers to the time when the order should be loaded.

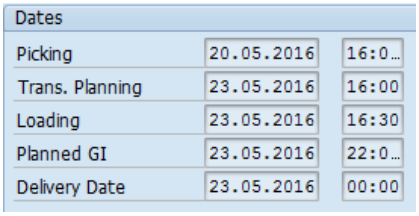


Figure 4.3.3.1. *Route dates.*

Several Metso sales and service offices in Europe use inter-company sales orders (ICSO). ICSO is a sales order which SSO creates for other location's plant in SAP. An ICSO process is quite automatic for DCE. The person who enters an order is responsible for the accuracy of the information. If the customer has created the order directly to SAP, it is not always released anymore. The order may automatically move forward without a delay. In other words, it is crucial that the orders are correctly placed. Some of the ICSOs are released by the order desk team. It is essential to monitor ICSOs in SAP, at least if a releasing process is not in use. Thus, the order desk and logistics teams are aware of the orders, and can make corrections in them. The customer service representative and logistics coordinator can check the net weight and delivery priority, and based on these whether the chosen forwarder is correct or not. In addition, they can check from a list if the order is blocked in some way. A block may be, for example, a credit block when a customer has issues in payments or the credit limit has been exceeded. ICSOs are delivered mostly directly to an end customer.

Internet Sales (ISA) is a web portal for distributors (see Figure 4.3.3.2.). This figure presents what the customer is able to define itself in an extranet during making an ISA order. The distributors create orders mostly in ISA but the portal is not yet used by all of the distributors. The distributors can make quotations and orders via the extranet. When an order is in ISA, data is automatically transferred into SAP and – in most of the cases – a block forms. If there is a block in the order, the order cannot proceed. The order desk team follows ISA orders in SAP. The customer service representative releases the block of the order in SAP and confirms the ISA order. Whether a block for ICSOs and ISA orders are in use depends on the DC and the customer. The removal of ICSO and ISA blocks and so shortening of the lead time is the ongoing project in DCE. In addition, the incoterm and the payer need to be changed manually in SAP if necessary because it is not possible in ISA. Furthermore, the partners' information and the forwarder need to be checked and corrected if necessary. ISA web portal has a few forwarders to choose from. These options depend on the customer and customers' location. The options are not same for every customer, and they come from customer data in SAP. Certain information is set as a default behind the customer data. If the customer has remarks, those can be written in the text box. The customer service representative can see the text immediately when the order is opened in SAP. The text may be, for example, a new ship-to address. Metso Minerals maintains data in SAP and creates new addresses behind the customer data. When the order is confirmed in SAP, a confirmation is sent to the customer. All Metso

Minerals' units do not use ISA orders. Among the interviewed units, DCE is the only unit using ISA.

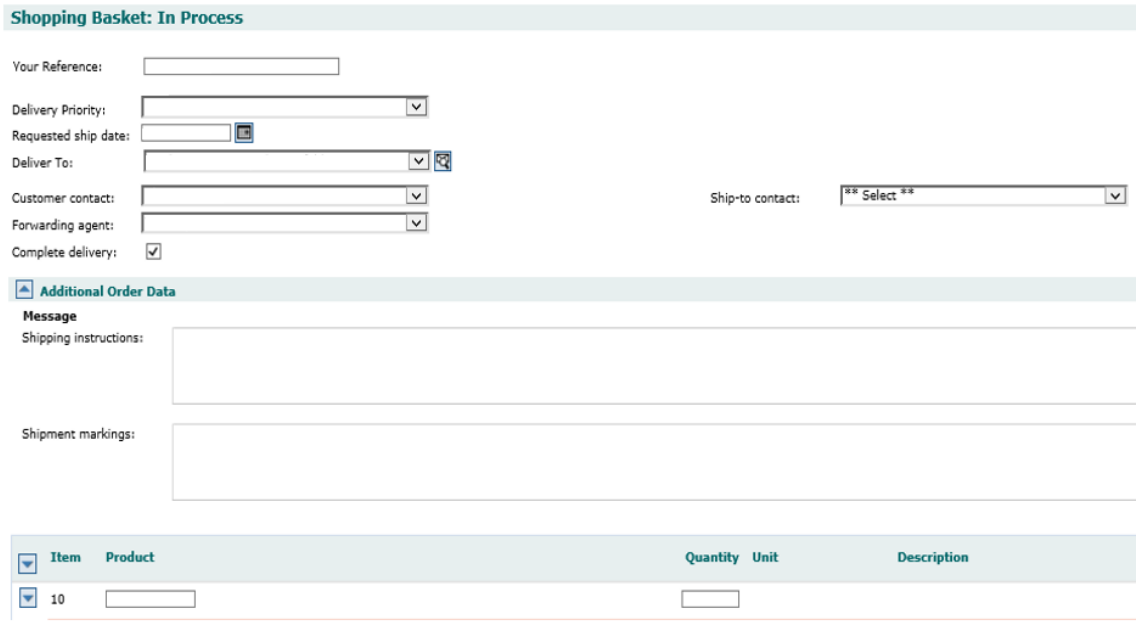


Figure 4.3.3.2. *ISA ordering on the extranet.*

Inter-company purchase orders (ICPO) or stock replenishment orders are done by DC or SSO. ICPO means that a Metso unit buys material from another Metso unit as stock orders. The unit which receives the order, sees it in SAP and releases it. Before the release, the incoterm and forwarder chosen by the customer are checked. On the basis of the forwarder, the route is defined automatically. A route in SAP defines the schedule for the order from the perspective of the warehouse and transportation. The purchaser in one unit enters an order for another Metso unit's plant, and the order is delivered to a stock of the subscriber organization. In ICPOs the delivery date is the date when the order will arrive to the customer. In other order types the date is a dispatch date. For ICPOs, the arrival date is often a certain weekday in each location. The purchasers in the ordering Metso unit see in SAP if material is not available, and the date can be optimized accordingly. ICPO orders are similar in all Metso Minerals locations.

Emails are one of the most time-consuming tasks of teams. The order desk gets emails mostly from customers who want to have their orders earlier as planned. In these cases, the order desk team contacts the purchase team and asks for the date when the parts are available in the warehouse. If the order is late, the urgency of the order may change. This means that the delivery priority has to be changed to breakdown, in which case a warehouse prioritizes the order. Customers also want to have a confirmation that the order will be shipped as planned.

4.3.4 Warehouse Operations and Packaging

This section deals with warehouse operations and especially optimal packing depending on a mode of transportation. Warehouse operations are in the range of inbound and outbound logistics. The main operations of a warehouse are presented next. Warehouses receive the goods which the purchasing teams have ordered from the suppliers. Transfers between warehouses are also possible. Warehouses handle the received goods by unloading them, checking them, and putting on the warehouse location. When a customer orders a product, the warehouse's personnel pick material from the warehouse location and pack it individually or in the same package with other products of the order. When the order is picked and packed, the packing details will enable the shipment creation in SAP and booking to a forwarder, finally the warehouse loads the order to the transportation equipment. The warehouse process of DCE's warehouses is similar to the process presented in theory.

Metso Minerals sells a substantial amount of different parts. For example, DCE has approximately 20 000 different products. Customers may order a single item or many parts together. The weight of an order may vary, and dimensions are not standardized. Because of this, there are nearly as many ways to pack the order as there are orders. When material is available for the order, transfer orders (TO) are first made in SAP, after which the data goes to scanners that are used in warehouses of DCE. The picking list shows the customer and forwarder, which materials need to be picked, and the net weight of material, as well as the total net weight of all materials. If the picking list is made by SAP and printed out, the scanner can read a delivery number directly from the list and list the items which the picker needs to pick. Warehouses handle delivery numbers which are a part of orders.

The order consists of one or several delivery numbers. Several delivery numbers are used if all materials of the order are not available at the same time and the order is delivered partially. A partial delivery is possible also if hazardous materials are shipped separately. When the scanner has read the delivery number from the picking list, it gives the stock place. The scanner also tells the picker which materials should be picked, in which quantity, and from which batch. If the goods do not have stickers yet, the stickers can be sent to a printer through the scanner. A few countries require that a country of origin is visible in material. When all parts for a specific delivery are picked, they are taken to a packing area.

According to the internal guide of DCE, warehouses personnel should check the optimal packing type for the selected mode of transportation. Karjalainen & Ramsland (1992, p. 212) point out that different modes of transportation are packed differently. The warehouses may have a pack checklist which is similar to a manual. The pack checklist gives information on the net weight of an order. The warehouse needs to take weight, dimensions and volume of the parts, and a mode of transportation into account before selecting the correct package type. For courier and air shipments, the warehouse should use as light

packing material as possible, but sharp edges are not acceptable for air shipments. Carton boxes are preferred for small courier or air freight orders, and also for road transportation if the order is small. For light and short shipments, a carton-box is the optimal packing material. For heavier shipments, a plywood case or a pallet-collar case is required. The most common pallet is a euro pallet which weighs 21 kilograms. A half of a euro pallet is commonly used as well.

Certain guidelines are meant to protect sensitive materials from corrosion and against mechanical and environmental influences. When packing ocean shipments, it is important to use anti corrosion plastic if there is a chance that the parts may rust. As Karjalainen & Ramsland (1992, p. 215) point out, damage to the goods is a threat in road transportation. Damages can be prevented by unitizing the goods (Karjalainen & Ramsland 1992, p. 215). The goods should not move in the box. The movement of goods can be prevented by fixing, blocking, bracing, filling or sectioning. In addition, the heaviest material should be packed to the bottom and the lightest on the top. When the order is packed, the package needs to be labeled for shipping. Other required documents have to be attached into the package as well. Figure 4.3.4.1. presents examples of pallet, carton, and plywood case.

Figure 4.3.4.1. *Pallet (DS Pallets 2016), carton (Unipack 2016), and plywood case (Woodland Export Packaging Ltd 2013) from left to right.*

Warehouses normally use pallets for packing because it is the fastest way to pack an order. A plywood box is equal in size to a pallet but it is lighter. Thus, it is often a cost-effective way to pack the order. It also has negative properties: plywood boxes are slower to assemble. This makes them less suitable for road shipments, and Metso Minerals arranges several road transportations.

Warehouses consist of inside and outside areas, as well as inbound and outbound areas. Incoming goods are handled in an inbound area, whereas leaving orders are shipped from an outbound area of a warehouse. In addition, warehouses have an office where the operations are arranged. Larger warehouses have their own cranes for moving large items. Warehouses make quality checks if the quality does not match the requirements. Other tasks of warehouses are unloading and loading containers, and arranging inspections. Stowing can happen either at Metso Minerals' warehouse or at a harbor. Customers may want the goods are inspected before shipping to ensure that the shipment corresponds to

the order. If the customer cancels or returns the order, the warehouse needs to take the goods back to stock.

4.3.5 Outbound Logistics

The outbound delivery process starts when a delivery is created in SAP. Delivery can be formed either automatically or manually when the order is confirmed. The delivery is automatically formed during batches in every 15 minutes. The delivery can be formed after the goods receival. The delivery cannot be formed if the material is not available. The delivery is formed for all available material simultaneously. DCE uses delivery splits which means that one delivery can weigh maximum of 7000 kilograms. This is a way to ensure that the delivery will fit in a single vehicle. When the delivery has been formed, transfer orders (TO) are formed. This means that the parts can be collected. TOs are created for all items separately. More than one TO may be formed for a part, if there are several batches from where the parts are taken. On the other hand, more than one part cannot be listed under an individual TO. TOs are formed automatically or manually. When TOs are formed, a picking list for the warehouse is printed. The warehouse uses a scanner to check what needs to be picked and into which order. For example, transportation planning date impacts on the order. There may be a stock error when the warehouse sends an ODR to DCE. When everything is in order and the order is picked, TOs are confirmed.

After the parts of the order have been picked, they will be moved to a packing area, where the warehouse's personnel pack the order using the pack list. The packing process was handled above. Packing is done near the correct shipping lane. A shipping lane is the place where packages locate when they are ready for pick up. Shipping lanes can be classified according to a mode of transportation, forwarder, country, or destination within a country. Shipping lanes are near the loading areas.

After the order is packed, the package type, net and gross weight, and dimensions are placed in SAP or directly in the scanner. Next, handling units are created in SAP, and post goods issue (PGI) is created in SAP. A formed PGI means that the order has been picked and packed, and it is ready for collection. When the order has been packed, it will be moved to the correct shipping lane. In Born warehouse, PGI is created during automatic batches. Instead in Tampere warehouse PGI is created manually. What has been described above is only an example on how the process in DCE works. In certain locations, PGI is the final step before invoicing. In the majority of the units, after the PGI formation the shipment forms automatically, or is formed manually in SAP for the majority of freight forwarders. A few forwarders do not need a shipment for a booking. All of the forwarders are not currently connected to MTG, which means that in certain cases bookings have to be done manually by sending an email. In the warehouse, waybills, packing lists and package labels are printed and attached to a package. If the shipment is going outside the European Union, an invoice for customs is needed.

The shipment is a communication method between SAP and MTG. The recommendation is that the shipment should be used in all locations to ensure a similar process flow in each location. MTG books the orders automatically after receiving the shipment information from SAP. An individual shipment includes one or several deliveries and one or more parcels. The forwarder receives the booking, sends confirmation of it and picks up the order. When the driver will come to pick up the goods, the pick-up reference is required before loading operations will be started. Some DCs' and MRE's warehouses use also scanners when the goods are loaded and scan every parcel. This facilitates subsequent investigations on if the order is loaded or not.

The final step in a document flow of an order in SAP is an invoice. When PGI has been done, invoicing is possible. Invoices can form automatically or be formed manually. The freight cost can be added to the invoice or it can be included in the price of the material. At times, customers arrange the delivery themselves and freight costs are charged from them by the forwarders. The incoterm and special processing ID determines if the freight is charged from the customer. Table 4.3.5.1. presents the basic situations of four most commonly used incoterms in DCE and the different ways to charge freight costs. The default incoterm is defined behind the sold-to party.

Table 4.3.5.1. *Freight cost and customs declaration compared to incoterm.*

	EXW	**FCA**	**CPT**	**DAP**
Customer arranges transportation	x	x		
Metso Minerals arranges transportation and order is delivered till port			x	
Metso Minerals arranges transportation and order is delivered directly to customer				x
Customer pays transportation directly to forwarder	x	x		
Metso Minerals pays transportation and charge freight cost on commercial invoice or it is included to material price			x	x
Metso Minerals is responsible for custom declaration		x	x	x
Customer is responsible for custom declaration	x			

Incoterms do not directly influence the party responsible for delivery arrangements or paying the freight. Instead, generally the party who pays the freight has also the responsibility of delivery arrangements. The party is defined by Special Processing ID in SAP. If Metso's legal entity pays the freight costs and arranges the delivery, it can also decide the mode and carrier of transportation. This means that Metso's contracts with forwarders are in use: Metso can influence the price of delivery as well. In these cases, the incoterm is mostly FCA, CPT or DAP. In order for a comparison of prices would be possible be-

tween individual forwarders, all service providers should have a same agreement including same pricing principles and end of the day, all prices shall be available for decision makers.

DCE uses DAP pricing as a way to charge the freight costs for orders. DAP pricing means that the freight cost is the certain percentage of the total amount of the order and it is included in the price of the parts. In these cases, DCE pays the freight costs to the forwarder so it is advantageous to choose the most cost-effective way to deliver the goods to the customer. Since Metso aims to be customer-oriented, the customers have the possibility to express their opinions. If the customer does not have any special needs, in DAP orders the customer service representative chooses the most rational mode of transportation and the appointed forwarder. If the customer wishes, for instance, that a heavy order is delivered by courier, it will be checked case by case if the mode of transportation is changed from truck to courier. On the other hand, if an order is light and small, but the customer has told that there is not any hurry with the order, it may nevertheless be booked for a courier because using a courier is the most cost-effective way to deliver the order. For light orders, a courier is cheaper, faster, and more reliable way of delivery.

Incoterm CPT is another option for shipments charged from DCE and for which DCE charges the freight costs from the customer. CPT usually means that the order is picked up from a warehouse by a nominated forwarder and is delivered to a seaport or airport. The customer arranges a delivery from the port to the final destination.

If the customer pays the freight, DCE cannot define the forwarder. However, DCE can ask the customer to confirm the forwarder, if the forwarder chosen by the customer appears inappropriate. If the incoterm is EXW or FCA, the customer generally pays the freight cost directly to a forwarder. In these cases, the customer takes care of arranging the delivery, or then Metso Minerals can arrange the delivery on the customer's behalf if the customer informs the account number to DCE.

Special processing ID means the payer for freight. There are four special processing IDs in use. The options are prepay and allow, prepay and add to invoice, third party billing, and collect. Prepay and allow is for the orders where DCE pays the freight cost. The second option is similar to the first, but there DCE adds a freight cost to the invoice sent to the customer. The third option, third party billing, means that DCE arranges a delivery, but a customer’s account is forwarded to the forwarder, and the forwarder charges the customer directly. Special processing ID collect is used for EXW orders.

Transportation operations are not a core competence of Metso. Instead, Metso has focused to transportation management and arrangement by using 3PL service providers. Modern companies often buy transportation services from international transportation companies (Karrus 1998, p. 111). Metso has appointed forwarders from each departure country to each destination country. There is a nomination for all rational modes of transportation.

Regular or long-time contracts should be put out to tender (Karrus 1998, p. 112) as is Metso's policy.

4.3.6 Monitoring of Orders

The procurement, order desk, and logistics teams are able to follow the status of orders. DCE and MRE have a delivery monitoring tool in SAP which enable the monitoring of orders before they are shipped. All open orders can be monitored by using the report from the system called Every Angle. The teams may notice materials which are late from their orders. The shipping lane tool is useful for checking whether orders have left from the warehouse or not. It shows the loading date and time. In addition, if the order is ready and booked via MTG; the status of a delivery can be followed in MTG. All forwarders do not send a status to MTG. In these cases, the status can be checked from the forwarders' own tracking tool by using the tracking number of each delivery.

When the order is confirmed in SAP, various meters, such the outbound reliability, are activated. If service level agreement (SLA) needs to be calculated, the calculation starts from the creation of the order. SLA is the part of a contract which defines services which a service provider is providing and the required standard for the services (Cordall 2014, p. 1). If the lead time of the whole process needs to be calculated, orders where material is not available, or where the customer has requested a later shipment, are not taken into account. If the customer does not want to receive the order immediately, the requested delivery date and a first date, which means when the order will be shipped, are changed for a later time. Otherwise, the dispatch date is the next possible date of departure. The first date depends on availability of material, delivery priority, a mode of transportation, and a forwarder.

4.4 Process at MRE Düsseldorf, Germany

Metso Metal Recycling in Düsseldorf produces recycling machinery for processing metal scrap. Metal Recycling providers tailored solutions for the recycling industry. The main products are automobile shredders and shredder plants, pre-shredders, scrap shears, scrap baling presses, briquetting presses, turnings and metal crushers, and anode crushers. In addition, Metso Metal Recycling offers services including installation, commissioning, inspection, maintenance, and repairs. (Metso 2016b.) Weak metal prices affect the mining sector globally (Metso Oyj 2015, p. 9).

Metal Recycling in Metso Germany GmbH in Düsseldorf has two processes: for make-to-order (MTO) parts, and make-to-stock (MTS) parts. Order types in DC Düsseldorf are PO/SO and ICSO which are used inside Europe. Metal Recycling does not have ICPOs or ISA orders. DC Düsseldorf sells parts and services to an equal degree, and aims to develop its services business.

Purchase requisitions come from Prime or inventory planning team. When a sales order is made, the purchasing team checks if the part is MTO or MTS. In case of MTS part, the order entry team sends an order acknowledgement (OA) to the customer. When the material is in stock, the delivery is created automatically in SAP, and a warehouse may start to pick and pack the order. The warehouse has time schedules which determine how fast standard, express, and breakdown orders have to be packed. The warehouse checks route schedules which tell when the order has to be picked, what is the transportation planning date, when the order is loaded, and when the goods issue must be formed. In addition, the route schedule tells delivery and billing dates. An automatic post goods issue is formed after packing, similarly as in the process at DCE. Next, an automatic shipment for a standard delivery is formed. Only shipments for ocean carriers are made manually because an export declaration from the warehouse is needed. In the future, shipments for ocean carriers will be automatized as well, as carriers will start making export declarations. After the shipment creation in SAP, a booking is made either automatically or manually in MTG. Nearly all bookings are made automatically, according to the information in SAP.

Invoices are needed for export documents, so orders to export countries are invoiced immediately. Documents are sent to the forwarder by email after an MTG booking. If the order is shipped to Germany, the logistics coordinator invoices orders two days after the shipment has left from the warehouse. With ICSO orders Metso Germany is required to wait that the ordering locations has invoiced its customer first. After that, Metso Germany can charge the ordering location. This is the standard ICSO procedure at Metso Minerals. Other orders are invoiced when the order is ready for pick-up. Depending on the customer, loading, pick up, and transportation take place before or after invoicing.

MTO process begins when a sales order is entered into SAP. After this, the order desk and procurement handle the purchase requisition, and the supplier supplies the material. As in DCE, a part of the suppliers uses P4T. The material is delivered to a MRE warehouse, and goods receipt is made in the warehouse. Next, the process continues similarly to the MTS process. Typically, orders are complete orders, which means that MTS materials may have to wait MTO parts.

The MTS and MTO processes described above are the basic processes of Metal Recycling. Like all units, the process in DC Düsseldorf has certain exceptions. The most significant exception is the high quantity of reversal PGIs. Compared to the recent past, the processes of Metal Recycling in Düsseldorf have grown similar to the processes in other Metso Minerals units. Before DC Düsseldorf created a PGI manually after they had checked that a delivery was okay. In addition, automatic shipments are seen in a positive light. MRE Düsseldorf has become more automatized, which means that monitoring is required.

4.5 Process at DC Trelleborg, Sweden

The main products of Metso Minerals Trelleborg are the parts manufactured on location: lining and screening media. Metso Minerals Trelleborg is also the center for mining crusher and the main inventory for those parts in Europe. Customers of mining area are located mainly in northern parts of Sweden, Finland and Norway. DC Trelleborg is the 4th largest Metso DC.

Metso Minerals Trelleborg has two plants: a manufacturing plant and a DC plant which are automatically integrated. DC Trelleborg does not use STOs from the manufacturing plant to the DC plant. When an order from manufacturing is ready, it is available for the DC plant and time is not lost on the goods receival. DC Trelleborg has a warehouse in Trelleborg and a satellite warehouse in the north of Sweden.

Purchase requisitions and a manufacturing plan are the first steps of the process. The inbound process starts from the demand, normally in SAP by Prime. If Prime is not followed, DC Trelleborg contacts the global planner or creates a PO in SAP before the purchase requisition has been placed. If a part is not in a stock, material is purchased mainly from a default supplier. Certain parts are manufactured and designed in Metso Minerals Trelleborg, whereas the rest are purchased from suppliers. Data transfers between P4T and SAP but all of the suppliers do not use P4T.

If material is not a make-to-stock (MTS) part, it is probably a make-to-order (MTO) part. MTOs represent a significant challenge to the process. DC Trelleborg does not buy MTO parts periodically which means that it cannot rely on the prices or lead times given by the supplier. This means that DC Trelleborg does not have an agreement with the supplier because MTOs are not bought at regular intervals. If a MTO part is ordered from DC Trelleborg and the order is a breakdown order, all non-urgent production ceases and the resources are reserved for the manufacture of the MTO part. Occasionally, breakdown orders are misused if the lead time for a part is protracted. The costs for breakdown order should be higher, or the sales person should have a permission from the sales manager to place a breakdown order. However, the number of breakdown orders in DC Trelleborg is not high. In DC Trelleborg, express order means that parts are in stock and they are needed immediately.

The majority of the customers, approximately 90%, are Metso SSOs. Metso Minerals Trelleborg has an email box where internal and external customers place their orders. The customer service team registers the orders into the system. A few of Metso's locations place orders (ICSO) directly into SAP and customer service team merely releases them. Orders need handling before they can be entered if they contain MTO parts which are not standard products. First, an engineering team needs to solve material number and other details, including calculation of prices. One of the main tasks of the order desk team is to monitor orders and check the statuses of orders because the aim is to be proactive.

DC Trelleborg has an automated delivery creation for MTS parts when SAP notices that everything is available. Since spring 2016, DC Trelleborg has used routes which means that route schedules are in use. When material is available in the warehouse, the personnel is able to work with the most urgent order first. The warehouse picks and packs the order, and labels it. In the warehouse, forklifts have an access to SAP via computers. DC Trelleborg uses scanners as a part of the process. In a few processes it is faster to do transactions directly to SAP than to the scanner. Efficiency can be achieved in this way, so DC Trelleborg is not willing to follow the shared process model.

When the order is packed, the main work of the logistics team starts. At times orders may be packed in advance. The logistics team can check deliveries from a list in SAP as soon as the delivery has been formed. They can refer to the list if they need to know what is shipping on a given day. If necessary, orders can be prebooked. The warehouse attaches the packing list to the cargo; a copy of the list is printed for the logistics team. The logistics team checks the delivery and if the incoterm is CPT or DAP the team creates the shipment manually in SAP. By creating manual shipments, DC Trelleborg can keep a control of deliveries and consolidate them. The logistics team also checks the most rational way to deliver the order and if necessary, they change the forwarder.

For standard orders, the customer service team chooses the most inexpensive basic forwarder. This means that road transportation is chosen for almost all shipments to Europe; for over sea shipments the choice is ocean freight. If the order weighs only 5 kg and there are no other shipments to a certain destination, the logistics team changes the mode of transportation to courier because it cost-efficient and fast. The breakpoints have either been committed to memory or are checked manually. The information from SAP reaches MTG and the booking is sent to the forwarder. The most common modes of transportation in DC Trelleborg are ocean and road.

In several Metso warehouses, the shipment is formed in SAP after PGI. In DC Trelleborg, the shipment is made before PGI; PGI is done after the truck has left from the warehouse. There may be exceptions if the documents are needed for deliveries. Invoicing can be done after PGI. Thus, in DC Trelleborg an order is not normally invoiced before it is shipped.

4.6 Process at DC/SSO Mâcon, France

Metso Minerals Mâcon produces mainly classic products. There are purchasing, back office and logistics departments in DC/SSO Mâcon. The purchase and logistics teams handle only items which are under Mâcon's sales organization. Similarly to DCE and MRE, if an ordered item is not in stock, the system creates a requisition and purchasing department makes a PO. Metso Minerals France uses the purchase requisitions and P4T with internal and external suppliers. Using ICSOs, the back office can place orders to five Metso Minerals' locations, such as to Metso Minerals Sweden. DC Mâcon also receives

ICSOs from other Metso Minerals units, such as from Metso Minerals Finland, Sweden and Germany. DC Mâcon has ICPO, PO/SO and STO orders, but not ISA orders.

DC Mâcon receives orders from end customers and Metso Minerals' units. Technical investigation is needed for classic parts before placing an order to make sure that the DC sends correct goods to an end customer. This information is sent to the customers that they can confirm a purchase order. POs are mainly from end customers and ICPOs are sent by Metso Minerals. If one of Metso locations sends a PO to another location, the second location creates a normal SO. Back office enters SOs in DC/SSO Mâcon. In ICSO process, the sales organization ships goods from a plant which belongs to another Metso Minerals unit. ICSOs may go directly to warehouse operations of a unit which has received the ICSO. Presently, the back office selects the mode of transportation and forwarder for ICSOs. When an order is placed for Metso Minerals Mâcon plant, dummy forwarders are used in SAP. These are similar to ocean freight, truck, taxi, or to be picked up which means that a customer arranges a delivery. This means that the nominated forwarder does not need to be known when placing an order.

Routes are in use in DC Mâcon. DC Mâcon has also automatic TO and delivery creations in SAP. When TOs are created, the warehouse can pick and pack an order. DC Mâcon warehouse receives the picking list and uses scanners to update the packing details to SAP during packing. When the order is picked and packed, the information of handling units is placed into SAP. PGI is done next. Shipments are created manually after the order has been packed and PGI has formed. The forwarder is chosen in this phase according to the selected mode of transportation already in the ordering phase. The booking goes through to MTG automatically after the shipment has been created. A few of export shipments are made manually in MTG: in these cases, there is no a shipment created in SAP. The logistics team at DC Mâcon is responsible for the delivery of goods when they are shipped from the warehouse in France.

For the most part, DC Mâcon uses incoterms EXW, FCA, CPT, CFR, CIF, and DAP. CFR and CPT are used mainly for export countries. In the case of an ex works shipment, PGI is made as soon as possible in order that Metso Minerals can inform the customer that the goods are ready for loading. Often the invoice is made one day after a shipment. Orders should not be invoiced before the goods are received by the end customer but DC Mâcon assumes that SLA agrees that the goods are shipped on time which means that the invoice can be created immediately after shipment.

4.7 Process at Domestic Sales, Finland

Domestic Sales in Finland sells products for domestic customers. End customers typically order material by email or phone. The sales person is contacted by the customer, and takes care of the order from start to finish. Approximately 30% of orders are urgent.

The process flow in SAP is similar to DCE. DCE takes care of many shipments within Finland. Domestic Sales in Finland does not use MTG so a tracking number is checked from SAP. The search for more information concerning the shipment is done in the forwarder's webpage. A common feature of domestic orders is that customers collect the orders themselves. In certain cases, the customer pays freight directly to the forwarder and at times Domestic Sales pays the freight and adds cost to the invoice of the customer.

4.8 Process at SSO Rugby, the United Kingdom

The process starts when a customer sends a quote. Customers are mainly end customers located in the United Kingdom and Ireland. Metso UK makes inter-company orders mostly to DCE as well as to DCs in France, Germany and Sweden. SAP shows where and when an item is available. If material is available in several plants, a default plant is chosen. At times customers order specific materials which are not open in SAP. Then, an item code for the material will be opened. In these cases, SSO UK creates a PO instead of an ICSO. In case of a breakdown order, SSO UK can order from anywhere. Metso UK sells parts and less services. Metso UK has a small warehouse where small items are stored and the aim is to keep the number of parts in the warehouse at minimum.

SSO UK chooses a route and forwarder for ICSOs. The choice depends on size of material. If the material is in a stock, standard delivery takes 5–7 days. The sales team in Rugby, the UK informs the customer about the dates. If the customer is satisfied with the standard delivery, an order is created in SAP. If the customer wants to change the dates, a status of a standard order is changed to a breakdown in SAP. Next the Rugby office informs the order desk team in DC about the breakdown order. Finally, a confirmation is sent to the customer. SSO UK informs the customer also when the goods are shipped. The customers want to be informed about the delivery dates. Occasionally, customers tell that they have not received the goods. In these cases, Metso UK contacts the selling organization. When the order has been delivered, it will be invoiced.

SSO UK offers breakdown services when the breakdown fee is charged. Freight costs are charged only from breakdown orders. The freight cost has to be confirmed by the customer. If the customer is not willing to pay the freight cost, the order is placed as a standard delivery. SSO in Rugby charges administration costs. When SSO UK receives an invoice from another Metso Minerals unit, freight costs are often included in the price of parts.

4.9 Differences and Similarities between the Units

The basic order-to-delivery process of DCE and MRE Düsseldorf is similar. They both have an automatic formation of delivery, PGI and shipment in most of the cases, and bookings are made in MTG. Relating to orders, ICSO process is in use also in MRE Düsseldorf and parts can be sent to DCs or end customers. DCE and MRE Düsseldorf use the

same central warehouse and same tools. In addition, MRE Düsseldorf has a few smaller warehouses. Both MRE Düsseldorf and DCE have variation in the sizes of the parts.

MRE Düsseldorf has lower volumes than DCE has. Unlike DCE, MRE Düsseldorf does not have ICPO or ISA orders, and it does not have distributors as customers. A major difference between DCE and MRE Düsseldorf is that DC Düsseldorf sells more MTO parts and services than DCE, but does not sell hazardous goods. MRE Düsseldorf has also simpler shipments than DCE has. This depends mainly on customer's locations and incoterms. MRE Düsseldorf has less breakdown orders than DCE. Their warehouse supplier in Born makes all export declarations for MRE Düsseldorf, whereas DCE mainly relies on the services of forwarders. This explains why shipments for ocean bookings are made manually in DC Düsseldorf. DCE creates an invoice as soon as possible, while in DC Düsseldorf domestic invoicing is done two days after shipping date. Table 4.9.1. presents similarities and differences of order-to-delivery process between DC Europe and DC Düsseldorf.

Table 4.9.1. *Similarities and differences between DCE and MRE.*

Similarity or difference compared to DCE	**Similar**	**Different**
Purchase requisitions from Prime	x	
P4T	x	
ICSO	x	
No ICSO blocks		x
ICPO		x
ISA		x
STO	x	
Distributors are customers		x
Hazardous materials		x
Automatic delivery creation	x	
Automatic PGI creation	x	
Automatic shipment creation	x	
Many size of parts	x	
Mainly MTS parts		x
Own warehouse(s)	x	
Scanners in warehouses	x	
Export declaration can be made by warehouse or forwarder		x
Invoicing		x

A similarity between DCE and DC Trelleborg is that both DCs have PO/SO, ICSO, and ICPO orders. When placing an order, a forwarder is chosen for the order, not for the

delivery. The methods for choosing the forwarder are different. DCE and DC Trelleborg both have routes in use in SAP, as well as automated delivery creation. Every Angle is used for monitoring orders in both locations.

Differences between DC Trelleborg and DCE include the more automatized process of DCE. Automated systems require careful monitoring and preparation for manual actions in challenging situations. Metso Minerals has people in several locations who enter orders to numerous locations. It is understandable that human errors may take place. For example, if the route or incoterm is not correct, the order may not be delivered. DC Trelleborg has several manual steps in the process to ensure that issues are discovered. For example, ICSO blocks are in use. DC Trelleborg does not use STO orders, but the parts are available in the DC plant when material is available in the manufacturing plant. Furthermore, ISA orders are not used. DCE's central warehouse use scanners for the whole processes, whereas DC Trelleborg does not. However, the underlying process is the same. DC Trelleborg manages shipments manually and PGI is done after the shipment has been created.

A breakdown order and express order have different meanings for DC Trelleborg and for DCE. For DC Trelleborg, a breakdown order is an order which has to be manufactured. Everything stops while the manufacture of the breakdown order begins. The express order is as urgent as the breakdown order but items are in a stock and can be sent in the same day when an order is received. Table 4.9.2. presents features of the order-to-delivery process in DC Trelleborg compared to DC Europe.

Table 4.9.2. *Similarities and differences between DCE and DC Trelleborg.*

Similarity or difference compared to DCE	**Similar**	**Different**
Purchase requisitions from Prime	x	
P4T	x	
ICSO	x	
No ICSO blocks		x
ICPO	x	
ISA		x
STO		x
Distributors are customers	x	
Hazardous materials	x	
Automatic delivery creation	x	
Automatic PGI creation		x
Automatic shipment creation		x
Many size of parts	x	
Mainly MTS parts		x
Own warehouse(s)	x	
Scanners in warehouses	x	x

Export declaration can be made by warehouse or forwarder		x
Invoicing		x

DC Mâcon and DCE have similar processes. They have automatic delivery and PGI creation. The most notable difference is that in DC Mâcon the shipments are made manually and the logistics team chooses the forwarder for the orders shipped from DC Mâcon. Metso Minerals Mâcon is also SSO which means that they sell orders directly to end customers as well. They receive orders directly from end customers. In addition, Metso Minerals France has its own production and it sells materials to other Metso locations. Table 4.9.3. presents similarities and differences of order-to-delivery process between DC Europe and DC/SSO Mâcon.

Table 4.9.3. *Similarities and differences between DCE and DC/SSO Mâcon.*

Similarity or difference compared to DCE	**Similar**	**Different**
Purchase requisitions from Prime	x	
P4T	x	
ICSO	x	
ICPO	x	
ISA		x
STO	x	
Hazardous materials	x	
Automatic delivery creation	x	
Automatic PGI creation	x	
Automatic shipment creation		x
Many size of parts	x	
Own warehouse(s)	x	
Scanners in warehouses	x	
Invoicing	x	

Metso Minerals UK is SSO which means that it is not directly comparable with DCE. SSO UK orders material mainly from DCE and its customers are usually end customers. In a manner, SSO UK is the customer of DCs.

The main differences between units are related to the creation of a post goods issue (PGI) and shipment. PGI is often created when the order has been completely packed but in DC Trelleborg it is created when the order has also been shipped. This means that, in DC Trelleborg, the shipment is created before PGI which is not possible in other units. These steps are shown in Figure 4.9.1.

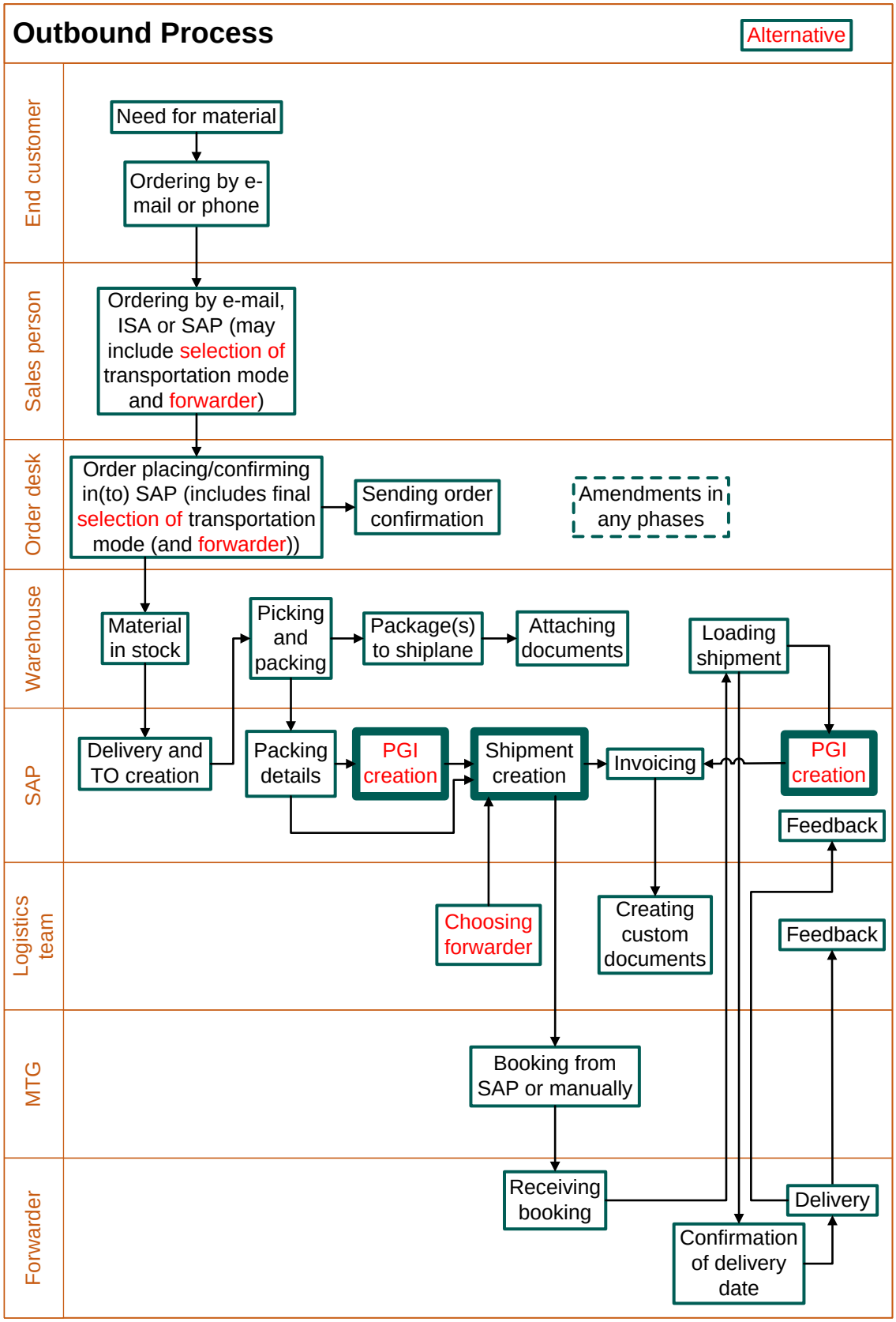


Figure 4.9.1. *PGI and shipment creation.*

Other differences are used order types and an amount of MTO and MTS parts. Invoicing methods are different between units as well as the automation level of the process.

5. PROS AND CONS OF THE ORDER-TO-DELIVERY PROCESS

This chapter describes mainly the existing problems of the order-to-delivery process based on the interviews. The main focus is on transportation issues. The interviewees have been presented above in Section 2.3.

Metso businesses have a plenty of data concerning orders and deliveries. In this thesis, the data was used to support the interviews. The aim of this thesis is to find ways to reduce costs and improve the quality and service of deliveries. Reducing transportation related costs cannot be checked only in transportation cost because choosing a forwarder takes also time as well as arranging special deliveries and several other tasks. In addition, delivery time, delivery reliability, and customer satisfaction are important factors. However, they will not be evaluated in this thesis in close detail. Development ideas presented in Chapter 6 have been collected by analyzing the interviews and data.

5.1 General Comments of the Process

The majority of interviewees argue that while the order-to-delivery process functions well, there is always room for improvement. The process develops constantly. In addition, the process flow in SAP, where all order related information is presented, is considered clear. However, one of the interviewees commented that in theory the process is good but in practice it should be more streamlined.

The interviewees describe the OTD process in DCE as advanced, fluent, and automatic. In contrast, in other locations, the process is not so automatic. One reason for this may be that there has not been time to develop processes, or employees think that there is not enough volume for automation. However, especially the process in DC Trelleborg is relatively manual. The personnel want to control actions which is easier manually than with by automatic solutions. There are also certain limitations which cannot be influenced by Metso, such as legislation, systems, transportation, and warehouses. For example, in some countries the invoicing cannot be done before the goods have arrived to the customer. This and similar issues cause delays for the process.

Processes have been developed recently in MRE Düsseldorf and DC Trelleborg. For example, DC Trelleborg has started to use routes in SAP which define a time schedule for an order. DC Düsseldorf has implemented new processes and obtained processes that are similar to the process in other Metso units. Learning from other units of Metso is recommended to prevent units repeating the same mistakes as other units have made.

For Metso, the customer comes first. This was reflected in the interviews as well. However, the requirements and desires of customers can only be met to the point which the process allows. The processes should be smooth to ensure their effective execution. If there are a lot of changes and exceptions in the order-to-delivery process, as for example DCE has, the process becomes more challenging. In addition, several partners may increase a diversity: controlling the process may become difficult.

5.1.1 Positive Aspects of the Order-to-Delivery Process

This chapter discusses the current positive aspects of the order-to-delivery process. In general, Metso Minerals has an efficient internal OTD process. The process is quite clear: it mainly consists of procurement, customer service and logistics. Approximately half of the interviewees perceive automation as beneficial for a functional order-to-delivery process. According to a number of interviewees, mainly from DC Trelleborg, semi-automated process is a suitable choice, whereas an automatic process without the loss of control is the preferred way to execute processes. The employees at DCE stressed that during automation everything should go well. Unfortunately, at times control is lacking which means that automated process can become vulnerable. In other words, there are pros and cons in automated process.

The OTD process in analyzed units is well-structured. The employees can follow the process effortlessly and plan actions in advance. In procurement, the system creates auto-POs faster than a purchaser would; however, this might lead to a loss of visibility. P4T is a useful system because it is not necessary to enter data manually into SAP. Instead, the data is transferred automatically from P4T into SAP. An order can be followed with a referral number received from P4T. If a supplier uses MTG, the number of information queries from suppliers is reduced. ICPO and ICSO processes are useful when the customers make their orders on their own. This means that it is not necessary to enter the same information into the system twice: this saves time when ordering materials from another Metso location. In addition, the amount of mistakes is reduced. Monitoring is, naturally, necessary in these situations in the selling location. Routes are also useful: when routes are placed for an order, the date cannot be entered incorrectly by mistake. Routes are extremely useful for a warehouse for the prioritization of packing. When orders are placed, SAP releases deliveries and TOs automatically. The orders can be conveniently followed from Every Angle.

One important matter for a functional process is that material is available if an order, such as spare parts for a machine often are, is required immediately. Information has to be updated constantly. The design of warehouses and delivery of MTS components are on a satisfactory level. The OTD process is mainly based on warehouses, so it is important to have stored materials. Conveniently, the warehouses use same SAP as Metso Minerals which makes the process easier to follow. The same system should be used in all locations

to ensure better understanding and facilitation of operations. This means that substituting of a colleague would be simpler.

DCE follows the order-to-delivery process closely, and the process is innovative and fluent. The process is well-described, and the process flow is clear in SAP. DCE needs well-described processes in its operations, including exceptional situations. The interviewees were mainly satisfied with their unit's processes. The whole supply chain is quite visible, and each employee knows what to do in each phase and how to follow up orders.

5.1.2 Challenges of the Order-to-Delivery Process

This chapter presents problems which can be related to several phases of the order-to-delivery process, and which are connected to several steps. In general, the main challenges are exceptions of any kind, manual actions, human errors, modifications after the order has been placed, low visibility of the process, and a lack and errors of master data in SAP.

Three of the interviewees saw **exceptions** as the main problematic issue. Volume in DCE is high which means that employees have to memorize several exceptions. Exceptions require manual work and they may cause errors and changes which in turn need extra effort in every non-standard stage. The main cause of exceptions are customers' or forwarders' requirements. At times the booking has to be done manually, a special loading is needed or the delivery fails. Any deviance from the basic process can be perceived as an exception. If the process is automatized and manual work is required, exceptions occurs. Clear sub-processes should be in use in each exception situation. However, not all of the sub-processes have been clearly described or instructed. Process models for sub-processes would improve working with these exceptions. Thus, handling exceptions would be more efficient, and the exceptions would not need to banned. Processes are heavy because there are many steps.

In order to handle the exceptions more efficiently, Metso Minerals should understand why the customer has a need for an exception and have guidelines for operating in those situations. Customer centricity is important, but working according to customers' processes is not always effective. The company cannot be customer-oriented, if it operates only according to its own core processes. If Metso Minerals had a single process, and everything operated smoothly, errors could be reduced.

Manual actions require unnecessary resources starting from manual order handling. If the customer and the sales person do not understand each other, problems and contradictory information may increase. Manual work, such as releasing credit blocks, is time-consuming. Another example of manual actions in DCE is that logistics coordinators check from a list twice per day the orders which contain hazardous material and inform

the forwarder. Manual actions appear in every step of the process. They are more a rule than an exception.

Human errors may also take place in any phase. These errors are usually noticed in the next step of the process or at the latest in the final step when the order become blocked. Automation could prevent human errors. It would, for example, minimize the amount of possibility of errors when creating an order. The process is vulnerable: many things can fail if item category, route, forwarder, or first possible shipping date is not placed correctly. Every tick is substantive when placing an order. If the tick is not placed correctly, in the worst case it may lead to delays in the order. The orders should be monitored more efficiently. However, the possibility of human error remains, even if the personnel is well-trained.

Amendments are one of the main challenges. A definition for process flexibility is that whether companies may amend existing orders if customers require it (Holweg & Pil 2001, p. 74). At times, efficient processes may be in conflict with flexibility and better customer service. The longer processes have progressed; the more difficult changes will be. If the warehouse has already proceeded with the order, entering amended information into SAP is complicated. Modifications may include, for example, a wrong forwarder on an order or a ship-to address which need to be corrected. At times, the material may not be available or a route is missing in SAP which lead to the fact that a shipment cannot be formed. There may be, for example, more than one plant in the complete order which should leave from a single plant. For example, presently a truck may collect a light shipment if a small delivery has not been noticed and changed beforehand. Partial deliveries may cause this. There are many issues which may cause that the order is not shipped. With automatized processes, first cancelling and then manually entering an action is time-consuming. An example is the cancellation of PGI. DCE, DC Düsseldorf, and DC Mâcon have an automatic PGI creation. If the order has a wrong forwarder, ship-to address, or zero weight, the cancellation of PGI can be made manually. If the entered information is incorrect, correction of errors may require unnecessary resources. If everything is entered correctly, the order proceeds well. It should be possible to update amendments into MTG as well, and the forwarder should have an alert about the latest amendment.

Purchase team has **low visibility**: as a result of Prime and auto-POs, the purchase team does not validate orders anymore. The purchaser does not know what the demand for an order is. The purchaser must trust Prime that a need for material is coming. At times, purchase requisitions may be presented even if there have not been sales orders. This helps the balancing between warehouses. Visibility disappears from the logistics team after the order has shipped. Because of this, the forwarders should inform Metso Minerals about deliveries in more detail.

Transparency and accuracy of data could reduce work and would make a chain simpler and shorter. During the interviews, a commonly mentioned fact concerning the process

was that Metso Minerals has **a lack of correct master data**. The lack of master data causes slowness and creates obstacles for developing a smoother process. The correct master data could form the basis for several development projects. In addition, the incorrectness increases the amount of manual work in logistics teams and warehouses. Most errors and lacks occur in dimensions, weights, and custom codes of materials. For example, if the master data were correct, a package type could be decided and shipments could be consolidated in earlier phase of the process. A box calculator could tell size of material and picking would be made by using the final box. Thus, Metso Minerals could make prebookings as well and forwarders could reserve vehicles for Metso Minerals as well as pick up the orders possibly 24 hours earlier. It would also be possible to make consolidation when the order is released. These actions could save costs in warehousing and logistics. The quantity of documents would decrease in warehouses, and package modules would be larger. Without correct weights and dimensions, it is impossible to know how orders should be packed. If custom codes were correct, customs clearance could be done electronically. In order for automation to be successful, the master data has to be correct.

Because the master data is not correct, at times there an incorrect data is printed to documents and corrections require considerable time. In addition, as regards certain destinations, incorrect data in documents might be pernicious. The weight of an order cannot be incorrect but warehouses cannot check that net weight of every item is correct. Similar problems exist in different units. If the information in SAP were correct, many operations would be smoother. The maintenance of updated data is important to take into consideration, if the data is corrected. Automation could be a possible solution.

5.1.3 Stakeholders

All the teams handled in this thesis have several stakeholders. Table 5.1.3.1. presents key stakeholders of purchasing, sales, order desk, and logistics teams.

Table 5.1.3.1. *Stakeholders.*

	Purchase team	**Sales**	**Order desk**	**Logistics team**
Customer		x	x	x
Item opening	x		x	
Product support	x	x	x	x
Prime	x		x	x
Procurement team		x	x	x
Planning	x			
Supplier	x			
Product line	x		x	x
Production	x			

Sales person	x		x	x
Order desk	x	x		x
Warehouse	x	x	x	x
Logistics team	x	x	x	
Forwarders	x		x	x
Global logistics				x
Chamber of Commerce				x
Customs				x
Service workshop	x			
Engineers of services		x		x
Development and support	x		x	x
Metso's other units	x	x	x	x

The teams are connected with each other. In addition, there are several internal and external partners and stakeholders. The main stakeholders of purchase, sales, order desk, and logistics teams are product support, warehouses, and Metso's other units. There are also other parties which are in contact with a single team. There are other contacts as well but the table presents only the major contacts.

5.1.4 Customer Feedback

Customers' expectations are high and Metso must be able to respond to the demands. Customers give both positive and negative feedback to Metso Minerals. When everything goes as planned, positive feedback may not be given, whereas if something goes wrong, the customers contact Metso Minerals. Feedback is often internal, given by a Metso unit according to the feedback which has been received from the end customers. Feedback does not depend on the unit. It is mainly related to deliveries because transportation is the most concrete thing for customers. More detailed feedback deals with delayed delivery time, wrong delivered parts, a status of a shipment, or a missing order. Occasionally, the customers claim that the lead time for material is too long, and they receive an order confirmation late. Freight costs have ceased to be a problem due to DAP pricing: charges have been included in the price of the orders items. This decreases questions about freight cost and saves time.

Customers have suggested that all units from where they order material should use same freight forwarders. A subscriber would not need to know where the order comes from. Remembering all forwarders from all plants and place a correct forwarder ID into SAP

presents a considerable challenge. Forwarder options may be placed behind a customer data.

Customers have mainly been satisfied with the customer service. Customers are satisfied if they receive parts on time. They cannot see the amount of work behind their order. However, customer satisfaction with both their order and the service is the most important thing for Metso. If there are some new and significant changes, such as stock transfers or system implementation, they may impact on customer service negatively.

5.2 Information Flow

Information flows in the order-to-delivery process will be presented next. Any essential information should be forwarded to the next party of the process. For example, the order desk should know what information is needed in the purchase team. Information is often available but stakeholders do not always know how to find and use it. All information regarding to a sales order should be entered into SAP and transportation related information copied into MTG. In general, all information should be shared with the other team because even seemingly insignificant piece of information may be significant for a colleague. Table 5.2.1. presents the information every party of the process receives and forwards.

Table 5.2.1. *Information flow in Metso Minerals' selected units.*

Input	Actor	Output
End customer has a need for material and he should be able to inform when and where the material is needed.	End customer	End customer sends an order by email or fax or call to SSO and inform details (i.e. material, quantity, ship-to address, contact information, unloading information) which are needed to make an order.
SSO receives an order and probably contacts to technicians. If the order is urgent, the end customer has informed it.	SSO	SSO may ask detailed information from end customers. When all information is clear, SSO checks where the part is available. If it is not in a stock, SSO contacts to purchase team. After that, SSO places an order into SAP (ICSO) or sends the details to order entry in DC (PO).

Order desk receives the order. Sometimes order desk receives questions about availability of material without an order.	Order desk	Order desk informs purchase team about a date when the order is needed if the order is urgent. Order desk keeps logistics team informed about urgency also. Order desk makes SO and sends an order confirmation to SSO. Order desk informs SSO if there are any changes or delays.
Normally information from customer's side is good enough. Customer service/order desk has done some work before information reaches purchase team.	Purchase	Purchase team should inform order desk if something does not go as planned.
In inbound process, all required information should be on a packing list and package label. Warehouse needs the following information for picking and packing from SAP: when the order should be packed, what is a forwarder, when the order needs to be shipped, where the order will be shipped to. SAP tells from which batch material has to be picked.	Warehouse	Warehouse fills a CoO and error code if necessary during they receive the goods. Otherwise SAP fills information itself. Warehouse updates stock placement which defines where material locates in the warehouse. Warehouse fills most of the information in SAP in inbound area. During picking a warehouse tells from which batch it has picked material. When a warehouse packs the order, Metso Minerals receives information of package details. Warehouse enters colli information to SAP. Warehouse tells also a loading date and time. All stakeholders who need information, can find it in SAP. Sometimes a warehouse sends emails if there occur some unexpected situations.
Logistics team receives most of the information from SAP or MTG. They can see when the order is ready for booking and invoicing. If the order is urgent, logistics team receives information from SSO or order desk that they can start to search special transportation.	Logistics	If the order is urgent, logistics team often asks a confirmation for freight costs from SSO. Logistics team sends an invoice to SSO when the order is ready. Logistics team keep order desk and SSO informed about changes of planned delivery. Sometimes logistics team informs a status of a shipment to SSO.

During normal transportation, a booking contains information from the order. Forwarder receives order mainly via MTG.	Forwarder	A forwarder informs if there is something wrong with shipments.

Communication methods, such as email, phone, or face-to-face communication, depend on the participants. End customers order material by sending an email or calling. Fax is occasionally used. Direct customers are in contact by phone if they are at a site and need an item. At times, the customer does not know the correct part number and the sales person may help on the phone immediately. When the sales person has received an input from the customer, the first step often is to figure out price, lead time, and delivery time for material. Occasionally, technical investigation is needed as well. After that the sales person is able to give a quotation. Details of MTO parts need to be investigated before the order can be placed into SAP. It may take considerable time before the order is in SAP, and an order confirmation can be sent to the customer.

Customers of DCs send an email listing the parts they need. When all information is available, the information is placed into SAP and an order confirmation is sent to a customer by email. Certain inter-company orders, ICSOs and ICPOs, are placed directly into SAP. A way to order does not depend on the location. If an order is normal PO, the order desk or back office places the order into SAP. ICPO, ICSO and ISA orders are placed by a distributor or SSO.

5.2.1 Placing a Perfect Order

An end customer should inform, first of all, what materials and in which quantity are needed, and when and where the parts are needed. According to the information given by the customer, the material code and quantity are placed into SAP. Other details of material come from material master data automatically. The required information for orders do not differ between locations. The order desk team has to know a plant and check availability of material. Complete or partial delivery needs to be chosen for each order. Sold-to party and ship-to party are the key data during ordering; they are often same as bill-to party. These details contain the name of the company and its address. The delivery address needs to be correct and clear: the order is delivered to the given address. Customer contact should be given as well to ensure that the forwarder can contact the end customer concerning the transportation issues.

The customer should inform about the urgency of the order, and based on the urgency and the weight of the material, give the mode of transportation as well. A few customers give the forwarding agent as well. The route is a combination of delivery priority, forwarding agent, and ship-to country. First date refers to the time when the order will be

shipped. It is based on delivery priority, forwarder and route. The freight payer is an important field related to the transportation. In comparison, the incoterm and the price are mainly formed on the basis of the contract, which means that they do not require as much attention. A number of things in master data, for example the net weight of material, come automatically to the order. If there is an exception, it is changed manually. It is also possible to enter open text into an order, which may contain, for example, shipping instructions, information about hazardous material or packing instructions for a warehouse. If the order is going directly to an end customer in an export country, pro forma is needed as an attachment. Both PO and SO numbers are placed into SAP for the identification of an order.

Part of the data behind the sold-to party moves from SAP to extranet ISA. The number of fields may be limited compared to the fields in SAP. Forwarding agents are same as in SAP behind the customer data. A ship-to address and contact information are also entered to ISA. If the distributor has a new ship-to address, customer service representative places it first into SAP, after which it becomes available in ISA as well. Distributors can also choose a forwarder for their order from a limited group of forwarders. An illustrative view of ISA has been presented in Section 4.3.3.

Customers should send their orders by email rather by phone. In the ideal situation, customers place the orders directly to a system, which means the sales person or order desk does not need to copy and paste the data. This reduces the amount of manual work: the order is placed only once, and the possibility of human error is lower. When customers place orders directly into SAP, all the necessary information should be available. However, there are differences between locations when placing orders into SAP. In ICSOs, the sales person has to enter the correct plant code, as well as the information required by the plant.

5.2.2 All Information is not Received at Once

The sales person and customer service representative often **need to ask more detailed questions** from customers because they have not received all the necessary information. A few of the interviewees saw amendments as a natural part of the process. However, the process would be more effective without changes. There were differences between answers from SSOs and DCs during interviews. SSOs stated that they rarely ask more information from end customers. A reason for this may be that end customers often order material by phone. If the customer is on phone, the back office can ask all required questions during one phone call. Amendments need to be made when the lead time is long. DCs and MRE need to correct data in SAP frequently. If there is something wrong with ICSO, the order desk should contact the person who placed the order to prevent the same mistake from repeating. If a similar order is placed more than once, it is often placed correctly. The need for amendments may at times result from ignorance. Occasionally they are clearly human errors or other mistakes caused by a lack of knowledge. The order

can also be entered according to the instructions of another location which do not work in the target location. Customers often ask for amendments for their orders. These commonly include faster delivery, cheaper price of delivery, or forwarder.

All information should be placed into SAP at the first time. However, there are several actions that need to be taken before that. Orders that are placed directly into SAP, are often in the right form, whereas the orders which are sent by email are not. If the customer orders a new item, for which there is no existing part number, a dummy article number is used. A dummy article number is mainly used in locations which receive numerous specialized orders and where there is a new item code for each measurement. End customers do not usually know serial numbers when they place their orders. Metso Minerals has to ask questions and request customers to send photos to determine the required material. Occasionally, the measurements or part numbers are checked with customers to prevent mistakes in part sizes.

The main changes are a cancellation, modification of the quantity of material on the order, or the change of delivery address, incoterm or forwarder. The delivery address is not given correctly every time, which means that MTG does not accept the booking. A name and phone number of the contact person are often missing as well. Incoterms may cause confusion: sales people may think incoterms are only for shipping department; however, customer service teams and sales persons should know how to use incoterms when selling items. In EXW or FCA orders, there is a dummy forwarder. When the order is ready, the logistics team has to confirm the real carrier from the order desk or the customer. If the customer has arranged a forwarder to collect the order, the warehouse needs information before the pick-up. Normally, the reason for pick-up is the need for a faster delivery (Karhunen et al. 2004, p. 383).

5.2.3 Experiences of Information Flow

The interviewees had similar views on the ways information moves inside the organization and between the organization and stakeholders. The general opinion was that information flow is sufficient within a location. However, between units, as well as between Metso Minerals and stakeholders, the information flow should be smoother. Different units of Metso Minerals should share information on, for example, appropriate operation models. For example, DCE and DC Trelleborg share several customers and forwarders, and a process is quite similar. In other words, both would benefit from better communication.

Communication and cooperation is enhanced if people are located close to each other: conversation between teams is easier. For the most part, internal cooperation is profitable in all units. The atmosphere is open, and colleagues can be consulted face-to-face or by email. Because the order desk and logistics team in DCE are located physically close to

each other, the process is faster. There were a few differences in the answers to the question if communication with the warehouse is easy. If the warehouse is close to the office, communication is uncomplicated, while if the warehouse is located farther, for example in a different country, communication is perceived as more difficult.

Communication between different locations is not satisfactory. Information flow is improving but there is still a gap between departments. A reason for the gap may be the number of people involved. A common weakness of in larger companies is the work flow. It may be difficult to find out who is a contact. It should be made sure that everyone knows who is doing and what. In addition, answers to requests are delayed at times. Metso Minerals should share more information between locations, and the company should work as one. This means that the processes should be harmonized. It would be easier for customers as well, if they and the sales people would have only one way to communicate with all distribution centers in Europe. All employees, regardless of location should be able to answer correctly and confidently to customers' questions regarding any order or material. Metso Minerals personnel can connect with each other but customers should have only one answer and response to their email. This way, Metso Minerals could be more effective, have a common way to do things, and serve customers better.

The information flow should be enhanced between Metso Minerals and stakeholders as well. If a purchaser has sent instructions to a supplier but the information has changed, the purchase team has not always received the new information. As a consequence, suppliers might use old instructions which causes unnecessary mistakes. The response time should be faster between Metso Minerals and suppliers as well as between and Metso Minerals and forwarders. For the most part, the communication between Metso Minerals and forwarders is carried out by email messages and feedback in meetings. Metso Minerals uses several forwarders, and there are many steps in the order-to-delivery process. Because of this, it is at times difficult to know where an order is located at each time. All the necessary information may not be available, either from forwarders or customers. For example, the delivery date might be unknown. Carriers have to inform shipment status to the company, as well as provide explanations for shipments which are not on time (Carter & Ferrin 1996, p. 59). Metso Minerals monitors orders carefully but cannot be as proactive to inform the customer about deviations as it would wish to be. The customer feedback base is a useful way to give feedback to Metso Minerals.

Information flows well in different systems. Metso Minerals has several manuals and instructions. Internal information and instructions are shared, for example, in intranet, SharePoint, Yammer and MTG. SharePoint contains information of transportation including instructions for checking a forwarder and delivery time. The customer instructions consist of a general manual; more specific information regarding to a certain order is mostly available in the email box. One of the problems with the information flow is the amount of data available: finding the essential information can be challenging.

5.3 Material Flow

Material flow is quite similar in all the Metso Minerals locations where the interviews were organized. An exception is SSO in the UK, who orders material from DCs and whose customers are mainly end customers. Thus, UK can be seen as "Customer" in Figures 5.3.1., 5.3.2., 5.3.3. and 5.3.4. Warehouses of DCE, DC Trelleborg, and DC Düsseldorf are "Metso Minerals' warehouse", and DC Mâcon is either "Metso Minerals' warehouse" or "Customer" in the figures below. The greatest difference between locations is that do they sell mostly MTO or MTS parts. The procurement team purchases material from internal or external suppliers, which can be located all over the world. According to the interviewees, regardless a unit, material flow is satisfactory but complicated.

If material is not available in a stock when the order comes in, it causes issues. A warehouse needs a great deal of time to handle material when it arrives to the warehouse. This significantly affects the fluent continuation of the process. In addition, MTO process may be time-consuming because manufacturing parts have to wait for sourcing, designing, calculating the price and lead time, planning order into system, and acquiring the raw materials. There are several steps in the process, and different people are responsible for different steps which means that it takes time to tell when a customer may have the parts.

In DC Trelleborg and DC Düsseldorf, most of the parts are MTOs. First, Metso Minerals produces the parts – or suppliers make the parts and send those to Metso Minerals warehouse. From the warehouse, the parts are sent to the customer. The customer can be another Metso Minerals location or a distributor. Next, the goods may be repacked and sent to an end customer directly or via Metso Minerals' SSO. There might also be certain additional actions in the process, such as painting. At times direct deliveries are used: material is delivered from a supplier directly to a customer. The direct delivery has a potential but requires a lot of improvement. Occasionally, the order is delivered directly to a port and from there to the customer. In addition, there are returning shipments from customers back to warehouses, but those will not be handled in this thesis.

Figures 5.3.1., 5.3.2., 5.3.3. and 5.3.4. below present main material flow at Metso Minerals. Different colors mean different solutions of material flows. Same colors in different figures do not mean a same thing. For example, STO can be transferred from production to a Metso Minerals warehouse, or from a warehouse to another warehouse. The material flow does not take forwarders' warehouses into consideration.

STOs are taken from own production or transferred from another Metso Minerals warehouse as presented in Figure 5.3.1. Prime advises from where balancing orders should be purchased. Procurement has also one time suppliers, which are not opened in SAP but from whom Metso Minerals can order supplies.

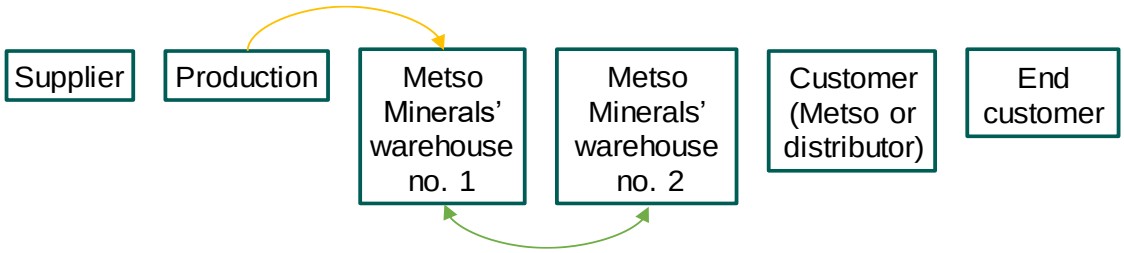


Figure 5.3.1. *Material flow of STO.*

Inter-company purchase orders are orders between Metso units. A Metso unit sells a product to another Metso unit. Stock replenishment orders are sold later to customers. This flow is presented in Figure 5.3.2.

Figure 5.3.2. *Material flow of ICPO (Metso → Metso).*

Inter-company sales orders mean that one unit of Metso makes an order for a plant of another unit of Metso. ICSOs are made directly to SAP. A delivery can be either to direct customer (Metso in this case) or an end customer. Cash flow goes through the SSO. Material flow of inter-company sales orders is presented in Figure 5.3.3.

Figure 5.3.3. *Material flow of ICSO.*

Material flow for PO or SO is the most diverse flow and it is shown in Figure 5.3.4. Third party deliveries can be used: the item is sent from a supplier directly to an end customer. A supplier can also send the product first to Metso Minerals, after which Metso Minerals organizes the delivery to the customer or customer's customer. The product can also be transferred from Metso Minerals' own production to Metso Minerals' warehouse, and from there to Metso Minerals' customer or the end customer. Another option is that material is in a stock, and it is delivered to the end customer directly or via the direct customer.

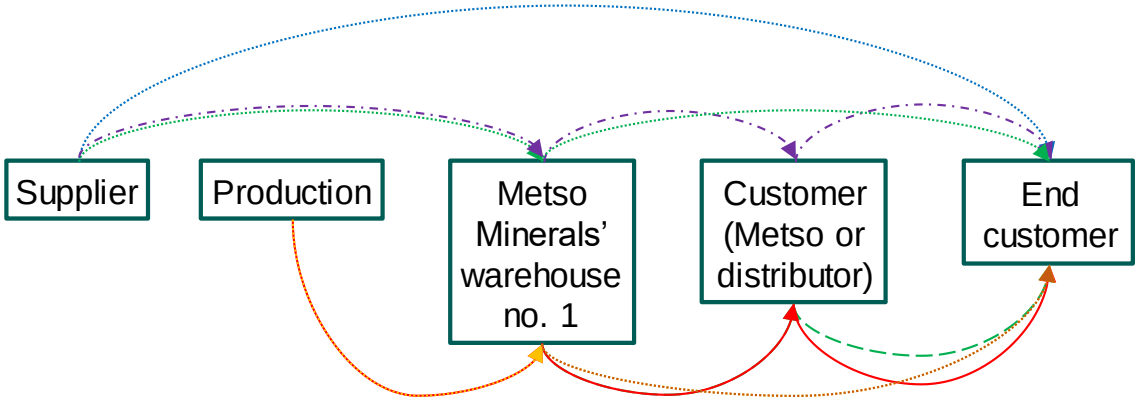


Figure 5.3.4. *Material flow of PO/SO.*

Metso Minerals has numerous intermediate stops and reload stations for material. Material flows via other Metso Minerals units, DCs and warehouses. More direct deliveries at least for MTO parts would be required from Metso Minerals. However, this is rather challenging because almost all of the deliveries should be checked individually. Direct deliveries can be complicated because supply chain contains several parties. Tax perspectives and document issues have to be considered as well. Direct delivery should be always an option but for sales it is convenient to ship material phase by phase. At least DC Düsseldorf arranges direct deliveries mostly from DC Prerov to Europe. DCE occasionally arranges direct deliveries for urgent orders, where there are no extra steps in the chain. The interviewees of DCE, DC Düsseldorf and DC Trelleborg thought that direct deliveries are a way to develop the material flow. Before arranging more direct deliveries, Metso Minerals needs to calculate possible savings in time and cash, and solve the formula for calculation. Direct deliveries are not profitable if they are highly labor intensive compared to the savings in deliveries and time. In addition, there are issues such as who organizes custom declarations, waybills, and transmission of the required documents that need to be solved. Metso Minerals should identify the chains of a standard process and direct delivery process. Next, it should be made comparisons between the two chains and calculate which chain is more cost-effective.

5.4 Challenges of the Ordering Stage

There are a few challenges in ordering phase of the order-to-delivery process. Ways to choose a mode of transportation will be discussed separately in the next sub chapter.

If the material is not available and the order is urgent, a clearing is needed. This means several emails and phone calls. If the material is not available early enough, customers may order it from another supplier which means a loss of sales for Metso Minerals. Delays may be caused also if a customer wants a complete delivery and an order contains two parts, one of which is available in one warehouse and another in another warehouse. Time is lost if one of the parts is shipped first to a Metso Minerals warehouse before the whole

order can be shipped to the customer. If an order is exceptionally urgent, it needs to be sent directly to the customer; it cannot be delivered via another warehouse first. A few units can make stock transfer orders between own production and warehouses only on the basis on the order. This means that the process is stiff: in urgent cases receiving a STO from the production takes considerable time. Certain units do not need an order for the transfer. For example, DCE could follow the DC Trelleborg model where the goods are available for DC as soon as they have been manufactured.

An example of an unnecessary action is **entering the same data twice**. Often the sales person sends the purchase order first, after which the order desk enters the sales order into the system. Metso Minerals should develop a way to place an order only once. Another problem is **the gap between ordering parts and services** which currently are two distinct processes. Instead, they should form a single large process that could be handled by a single employee. The current situation means that technicians are often on site waiting for the parts without knowing when the parts will arrive, or if they are on their way to the customer. The synchronization of large MTO parts with services represents a considerable challenge in DC Düsseldorf.

There is an individual process for each order type: ICSO, ICPO, ISA, PO. Metso Minerals has several different processes which means that the employees have to be aware of several rules and ways to operate. The processes are useful when they work; however, there is always the possibility for mistakes if the process includes several persons and there are many guidelines. While it is convenient that a customer can place an order, which means that the same details do not need to be placed twice, this may also cause problems at times. **ICSOs contain more errors than SOs**. This is understandable, because all persons who place orders may not have previously ordered from different plants, or are not used to choosing a forwarder for an order. A few Metso units use a general mode of transportation in the ordering phase and the logistics team chooses the forwarder after the order has been packed, whereas other Metso units may use an exact forwarding agent IDs in SAP during the placement of an order. If there is, for example, a general forwarder "truck" placed on an order for the plant which requires the exact forwarder, the order does not go through to MTG if the contradictory or inaccurate information is not changed before the shipment is formed. If the wrong forwarder is not noticed, the order may be delayed. This causes challenges in ICSOs which do not have a block. Other types of data, for example the payee or the postal code, may be incorrect in the order. The correction of errors is left for the end of the process, that is, the phase before the booking. Monitoring of ICSOs is meaningful because mistakes occur regularly.

Monitoring the orders is time-consuming but is nevertheless an important part of the process. Monitoring is important especially if sub-processes are automatized. However, certain aspects of the monitoring actions could be arranged more efficiently. For example, in order to avoid the unnecessary use of resources, SAP should automatically show if material is available or not. There are also challenges in monitoring. It is difficult for the

purchase team cannot follow their shipments. Because the tracking information is often not give, the purchase team needs to contact the supplier to obtain it. If more suppliers would use MTG, monitoring would be easier.

Another thing that requires plenty of time is **customer service**. It would be easier if the customer were to inform when the material should be delivered. Thus, the order desk could make rest of the choices based on this information. Customers often want to be involved in all decisions. Customers from other Metso units often ask for confirmations concerning, for example, shipping or delivery dates, when they could check them from SAP or MTG. This would save time for both the customer and customer service representative. Lead time, delivery time, stock information, and prices are regularly enquired about as well, despite the fact that the delivery plan and price list are sent to customers.

5.5 Choosing a Mode of Transportation

This chapter will focus on the current policies in the selection of the mode of transportation and forwarder, including both a SSO's and a DC's point of view. There were slight differences between different locations in the ways the mode of transportation and forwarder are chosen and who makes the choice.

The basic elements are similar in all locations. For the most part, bookings are made in SAP and MTG. If the forwarder is chosen for an order, not for a delivery, the choice is made on the initial stage of the order. If items need to be shipped by using a specific forwarder, the forwarder can be changed manually for an order line on a later stage.

5.5.1 Who Makes Transportation Decisions?

When spare and wear parts are ordered, customers should know if they need a product immediately, such as in situations where a machine is broken, or if they buy material at specified intervals to a warehouse. An end customer should know the delivery priority and, according to the priority, be able to choose a mode of transportation. Urgent shipments are delivered by courier or air freight, whereas standard orders are carried by ocean freight or truck. If the end customer is unable to determine the correct mode of transportation, the sales person can help as soon as the urgency and requested delivery date are known. At times, the end customers do not know what they want: in these cases, SSO should decide the correct mode of transportation for each order. Occasionally, the urgency is not disclosed, but the sales person can deduce it from given mode of transportation or just ask it.

The customer service representative in DC has to ask right questions from customers to check the urgency of an order. The order desk is well trained on delivery priorities and know how to choose the correct mode of transportation. The order desk can explain the options for customers if they are not familiar with them. The options depend on if the

material is on stock or not, on the weight of the material, on the date on which the order will be shipped, and on the carrier. When choosing a mode of transportation, departure and destination places are significant. Table 5.5.1.1. demonstrates the party who selects the delivery priority and the mode of transportation for orders in each interviewed unit of Metso Minerals.

Table 5.5.1.1. *A party who decides a delivery priority and a mode of transportation for an order.*

	Delivery priority	**Mode of transportation**
Domestic Sales	End customer	End customer
SSO UK	End customer	SSO UK
DC/SSO Mâcon	End customer	End customer
MRE Düsseldorf	Customer	Customer or MRE Düsseldorf
DC Trelleborg	Customer	DC Trelleborg
DC Europe	Customer	Customer

Based on the delivery priority, either the order desk, the sales person or the customer decides the best way to deliver the order. Customers of Domestic Sales are able to inform both a delivery priority and a mode of transportation. In the UK, SSO chooses the mode of transportation on the basis of the customer's needs. The end customer does not choose the mode. In the case of a breakdown order, SSO informs the customer about the options, after which customers choose how much they are prepared to pay for a fast delivery. In SSO Mâcon, the end customer announces both delivery priority and the mode of transportation for the order. A forwarder is chosen by the logistics team when the order is ready for shipping. If the order may be delayed, the mode of transportation is changed for a faster option. In DC Düsseldorf, DC Trelleborg and DCE, the customer, which is a distributor or a Metso sales and service office, often states the delivery priority. Both DC Düsseldorf and DC Trelleborg usually choose the mode of transportation according to a standard transportation option. If the order is urgent, a faster delivery, such as courier instead a truck, is chosen. If a special transportation, such as courier express delivery, is arranged, DC Düsseldorf charges transportation costs from a customer. DC Trelleborg charges extra costs from customers if taxi deliveries are arranged. Customers of DCE can choose from all standard delivery options: special options such as taxi are not included in these options. If special service is arranged, freight costs are charged.

ICSO and ICPO orders have always **a delivery priority mentioned** in SAP, while standard POs do not have – in order for standard orders to have delivery priority, it should be mentioned often **separately**. Occasionally customers mention in the PO that a mode of transportation needs to be selected according to the total weight of an order. They give the weight limits for each mode of transportation. If the delivery priority is not given, the

order is placed as a standard delivery. When customers receive the order confirmation, they often ask if they could receive the goods faster.

If the order is placed on an early stage, it is typically a standard order. It is problematic that if a customer has made a standard order but the goods are not in a stock or **material arrives late from supplier** the order becomes a breakdown order. Customers commonly announce that they need a fast delivery. Occasionally, they merely want to ensure that the order arrives on time: because of this, the order has to be delivered quickly. The urgency of an order can change rapidly in other situations as well. This is an issue if the order has already entered the picking process in a warehouse. If the process has started, any changes on the details of the order become complicated. If a normal delivery has been arranged, the modification of the order to a breakdown is difficult on the later stages.

The number of services provided by Metso increases constantly. Delivery priority does not cover the requested delivery date for service business. If a customer buys services, the technician must know when parts arrive on site. An urgency can be caused by a lack of coordination in service, or by delays in the delivery of parts. Requested delivery dates are communicated by email; they cannot be placed into SAP.

The interviews considered the possibility of placing the latest possible delivery date into SAP, when placing a sales order or inter-company sales order and the incoterm is DAP which means that Metso Minerals arranges a delivery to the customer. Currently, in ICPO and STO processes, the requested delivery date is entered: the order should be delivered to the customer by the given date. In comparison, in sales orders the date refers to the dispatching date. If the transit time of a STO from the Netherlands to Finland is two days, the requested delivery date minus two days tells when the order should be packed and loaded.

There are pros and cons in this arrangement. The date should be along during the whole process, starting from a need date from suppliers. If the requested delivery date is known, it would not probably make order handling easier but it may lead to other problems. On the other hand, if customers are able to estimate the date the parts are needed realistically, the order desk does not need to ask for it separately. This would be useful for planned services, because it would synchronize the process and parts and services would be on site at the same time. Transportation contracts might cause problems, if the requested delivery date were in use. If there is a single departure per week to an individual destination, and the order is packed a few hours after the loading time, the order will be delayed for one week. One of the challenges is to find ways to define dates: it becomes necessary to be able to know the time it takes the order to reach a given destination. Delivery dates could be added automatically by SAP. The transportation contracts would be taken into account in the automation. The forwarder provides delivery time: the arrival time is calculated based on the delivery time. The shipping date, in turn, is calculated based on the delivery time and the arrival time. If customers wish for a fast delivery, they should be

prepared to pay extra for it. The positive side is that this would increase customer centricity.

5.5.2 When Transportation Decisions Are Made?

Figure 5.5.2.1. presents the outbound process of Metso Minerals. It focuses on phases where the mode of transportation and forwarder are chosen. The edges of these stages have been bolded. The mode of transportation and the forwarder can be chosen during the ordering step or immediately before a booking.

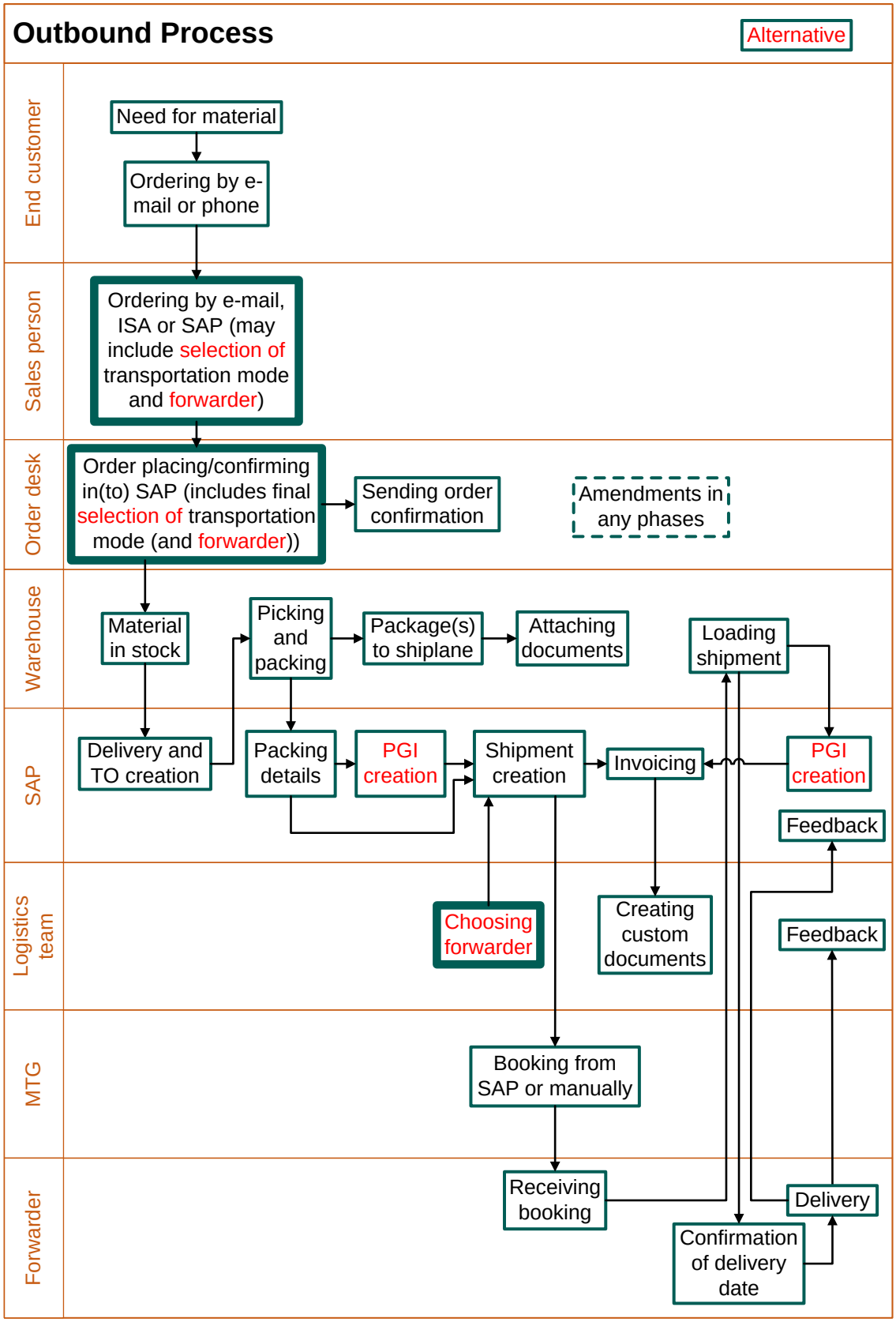


Figure 5.5.2.1. *Phases when a forwarder can be chosen.*

End customers of Domestic Sales in Finland announce the urgency in the ordering step: the mode of transportation and forwarder are chosen immediately when creating an order.

In comparison, when entering an order, SSOs notify DC of the urgency, the required mode of transportation, or the forwarder. If the end customer tells that an urgency has been changed, the mode of transportation and forwarder are tried to change later on.

In DCE, the mode of transportation and forwarder are selected by the order desk when the order is placed. If the order is divided into several separate deliveries, the logistics team may change the forwarder for the delivery later. The dispatch office coordinator occasionally chooses a forwarder if the order is inside Finland. The task of the dispatch office is to prepare dispatching loads (Karhunen et al. 2004, p. 382). Similarly, in DC Düsseldorf, the order entry or sales make the selection. They have a detailed manual, created by the logistics team, they can follow in all options and see the limitations of forwarders. Nominations are the essential factor in choosing a forwarder. According to the weight of the order, courier, road, air or sea freight is chosen. A truck is mainly used for shipments to Europe, but also as courier for lighter shipments. In DC Mâcon, the back office chooses the mode of transportation when creating an order, and the logistics team chooses the forwarder when the order is ready for shipping. The process of DC Trelleborg is similar to the process at DC Mâcon.

In DC Trelleborg, the customer service team chooses the mode of transportation and, according to the nominations, the forwarder as well. A unique feature is that they invariably select a forwarder according to the standard order: at this point, small shipments are not taken into account unless there is a demand for an urgent order. For example, even if the order would weigh only 1 kg, and ship-to address were in France, a trucking company would be selected, whereas for 1 kg to the USA, the customer service would select an ocean freight. When the delivery is picked and packed, and if the order is light and nothing else is not leaving to the same destination on the same day, the logistics team book a courier or an air freight. Occasionally, if the shipment of an order is rushed because the mode of transportation has switched for courier or air instead of truck or ocean freight, customers may not have unloading equipment on site. Because boxes in smaller and faster shipments are commonly light, unloading equipment is not needed. In addition, the customer should give information on the required equipment when the order is placed. If the customer service has placed the order directly for a courier, the logistics team knows that the order is urgent.

5.5.3 How Transportation Decisions Are Made and Who Arranges a Delivery?

The most important thing affecting to the selection of transportation is that whether the delivery is arranged by a customer or by Metso Minerals. If the incoterm is EXW or FCA, the customer often arranges the delivery. The customer will book a forwarder to pick up the order from the Metso Minerals warehouse. Thus, Metso Minerals cannot influence the choice; these cases are not handled in this thesis. In the case of EXW and FCA, Metso

Minerals occasionally books the delivery and uses the client's account number in MTG. If Metso Minerals arranges and pays the delivery, the urgency and weight are checked first. Naturally, the wishes of the customer are taken into account as well.

Regardless of the unit, urgency and weight are the most important things for choosing the mode of transportation. The basic rules in every location are:

- if an order is standard and heavy and going to Europe, use truck,
- if an order is standard and light and going to Europe, use courier,
- if an order is standard and heavy and going to outside Europe, use ocean freight,
- if an order is standard and light and going to outside Europe, use air freight or courier,
- if an order is urgent and heavy and going to Europe, use courier or special service,
- if an order is urgent and light and going to Europe, use courier or special service,
- if an order is urgent and heavy and going to outside Europe, use air freight, or
- if an order is urgent and light and going to outside Europe, use air freight, courier or special service.

Weight limits depend on the departure and destination countries. The urgency may change depending on availability of material. If parts are immediately available, the order is mostly standard; if they are not, the order may become a breakdown order. After urgency and weight comes the nomination for the country. Based on the nomination, the forwarder can be chosen. Contract forwarders are used in every location. However, they change constantly which means that old instructions may not be accurate. The nominated forwarder might seem an obvious choice, while the instructions may not, in fact, be correct anymore. The nominated forwarder is not used, if it has caused problems for customers or the service has not worked well to the given destination. For example, changing connections may mean that the delivery arrives a day later than previously. This is one reason to change the forwarder to a destination.

DCs do not normally check nominations from MTG. However, they do not need to remember a nomination to each country, because forwarders are updated behind the customer master data. There are options in every delivery priority. The regular options are truck, courier express, and courier economy options. For export countries, air freight and ocean freight are used instead of truck delivery. Some employees choose the mode of transportation by a feeling and experience. Instinct and the desire to read instructions affect the decision. An issue is that people who place orders tend to become familiar with certain forwarders, and use those regardless of whether they are suitable or not.

Costs are one criterion for choosing the mode of transportation and forwarder. Often costs are not compared because it is thought that the breakpoints are known. Volume weight, which is a more important factor than actual weight, may not be checked. It is often thought that a truck is cheaper than a courier for over 30+ kg packages. This assumption

is not always correct because there are minimum charges to certain destinations. Even though the package would weigh 30 kg, the price could be, for example, for 100 kg. The most difficult choice is the choice between a courier and truck. Breakpoints are not checked every time, because employees trust their experience. If breakpoints are unclear, they can be checked from the master rate sheets (MRS) of MTG. Breakpoints to most common countries are often known. If a destination is unusual, it takes time to check the breakpoints.

A special transportation is needed in case of extremely urgent orders. Arranging the transportation for a breakdown order differs between units. Some units have the same freight cost for breakdown orders and for standard orders, while other units charge the freight costs of breakdown orders every time. In addition, a few units charge the freight cost in breakdown orders only if special transportation is arranged. There are different breakdown orders in different units. Occasionally, the freight costs depend on how much a customer is willing to pay for the transportation. A DC and a SSO discuss concerning the way how a customer wants the order to be delivered: by taxi, courier, or truck. If there are no errors, such as not a delay caused by Metso, the customer always pays the special transportation. Deliveries for urgent orders are checked by the logistics team: this is a manual phase of the process. The logistics team often calls for offers from several forwarders before booking a shipment.

SSOs choose the mode of transportation according to the instructions. Each DC from which the parts are ordered, has set rules how to choose the mode of transportation and other additional information. Weight and urgency are two of the most important criteria in choosing a forwarder. If SSOs place orders to DCE, they have same instructions as DCE has internally. SSOs have been instructed on dimensions and breakpoints for weight. In addition, they have a schedule for different modes of transportation. It may be that SSOs have not received suitable instructions from all the plants; they might use the same information of available forwarders they have received when ICSO orders have been implemented. This means that information may not always be fresh. There are more problems with ICSO orders than with orders placed by the customer service representative in each DC. DC Trelleborg still has ICSO blocks: they send the order back to the person who entered ICSO, and ask the person to change the general forwarder to the correct one if necessary. A few DCs and SSOs have logistics departments which make the bookings. The process is different, because forwarders are checked at the booking step.

There are differences in the ways of thinking between countries. In DCE, the forwarder is chosen for the order individually. This is not an optimal way if the order consists of several deliveries. The logistics team should follow orders but this is not always possible due to high volumes. Because the process is automatic, goods can leave by less than optimal mode of transportation. In Sweden, the logistics team changes the forwarder if only a small package is leaving to a given destination – as happens quite often. The customer

service team does not choose the correct forwarder because they do not know how material will be packed. Furthermore, the master data may be incorrect which means that the optimal forwarder cannot be known. This is more controlled but manual and not so effective way. In comparison, DC Mâcon chooses the correct forwarder based on the promised delivery date when the order is packed. This means that their process is a manual process as well.

The list below demonstrates the factors which are taken into account when choosing the mode of transportation and forwarder for an order. Number 1 on the list was mentioned by several interviewees, whereas the final factor was mentioned only once during the interviews.

1. Nomination (contains a ship-to address)
2. Urgency and delivery time
3. Weight
4. Instructions
5. Experience and instinct
6. Costs
7. Incoterm
8. Customers' wishes
9. Familiar with a forwarder
10. Data behind the customer data

In conclusion, the critical factors in choosing the mode of transportation are observing the urgency and weight of the order. The forwarder is selected according to a nomination.

5.5.4 Selection of the Mode of Transportation in Inbound

In inbound orders, the forwarder depends on the arranging party of the delivery. Suppliers regularly book transportation for purchase orders. Similarly to outbound logistics, inbound logistics use nominated forwarders as well for the cases where Metso Minerals arranges or pays a delivery. A few suppliers use their own forwarders if they are more cost-efficient. If Metso Minerals pays the freight, suppliers should use nominated forwarders according to instructions. However, the suppliers do not always use them.

In inbound logistics, the forwarder is selected by checking the weight and urgency of the order. There is a default forwarder behind every supplier, but often the choice is left to the supplier’s notice. Suppliers have instructions on how to choose the mode of transportation. In the case of standard orders, the instructions should be followed. However, in the case of breakdown orders, the purchaser often wishes for a specific forwarder. The logistics coordinator at DCE has made booking templates for suppliers in MTG. There are one or several templates per delivery address and a forwarder. The supplier only needs

to fill the handling unit information and decide the forwarder for each booking according to instructions. The inbound process is presented in Figure 5.5.4.1.

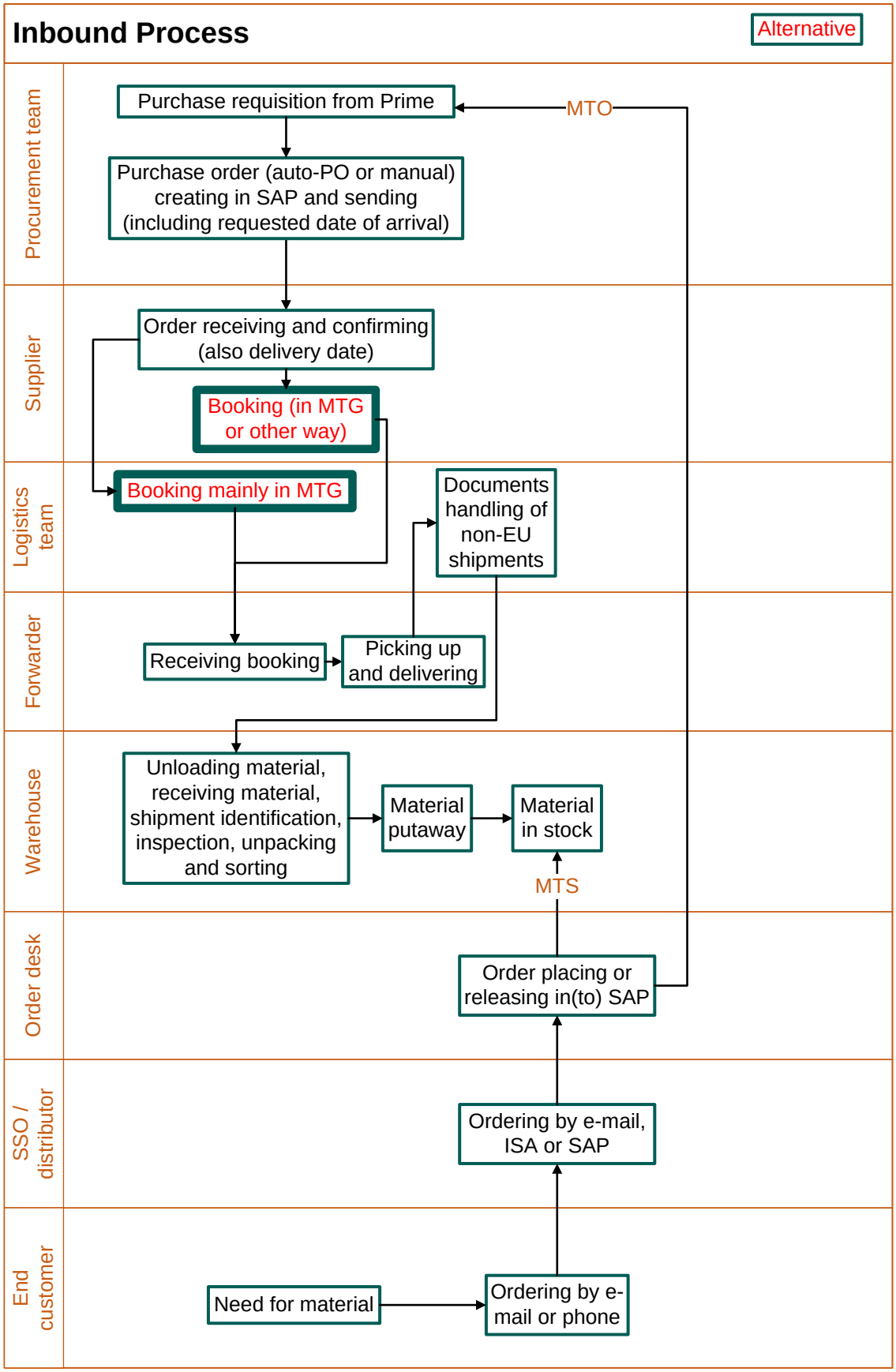


Figure 5.5.4.1. *Inbound booking process at Metso Minerals.*

The phases where a booking can be made are highlighted. In DC Trelleborg, most inbound bookings from Europe are booked in MTG. Suppliers may create bookings. In the rest of the cases, the suppliers announce that the goods are ready, after which the logistics team makes a booking in MTG. If the purchase team wishes for a certain forwarder, they must inform the inbound logistics coordinator separately.

5.5.5 Problems When Choosing the Forwarder and Mode of Transportation

Inbound bookings have simpler rules for choosing a mode of transportation than outbound logistics. The urgency and weight are the main conditions in inbound logistics. The purchase team cannot choose the mode of transportation because it is not known **how the order will be packed, and whether other materials will be leaving from the same supplier on the same day**. Neither are these matters known in outbound shipments, yet in DCE the forwarder is nevertheless chosen in the beginning of the process. This tends to lead into mistakes: indeed, one of the tasks of the logistics team is to notice the errors before the booking. Having the supplier make the booking may not solve the problem, because the forwarder for an inbound order should probably be changed. **A supplier does not necessarily use forwarders as instructed**, and instead uses forwarders which are defined as default for the orders they receive. For example, with lights orders, truck should be changed for courier shipment.

Errors are possible because **weight is not known** when placing an order. The difference between net and gross weight may be surprisingly large. Packaging material may bring a lot of extra weight for the order. There are also differences between net weights of an order and its delivery, if the order is sent in several parts. Thus, one delivery may weigh a few grams even though net weight of an order is hundred kilograms. This means that the mode of transportation chosen for an order may not be suitable for a delivery. The selection of the mode of transportation may be incorrect: thus, the mode of transportation and forwarder should not be chosen for an order, if the order is shipped in parts. This fact may present challenges if it is not taken into account. At times, the size of the material may present challenges if it is not taken into account when the order is made.

An issue that became apparent during the interviews is the fact that Metso Minerals has **an excess number of options for the choice of the mode of transportation and forwarder**. In addition, **the process**, selection, options and instructions are **distinctive in different locations**. There are separated forwarders in use in different plants used by ICSO customers. This makes ordering from different plants confusing for SSOs who order material from the many locations of Metso Minerals. Often the person who enters an order has to select a forwarding agent. Because of this, errors may occur when an order is placed and a forwarder is chosen. It would be pragmatic that customers, even though they are SSOs of Metso Minerals, would go through the same procedure when they order

material, regardless of the plant from where they order. While SSOs are competent in choosing forwarders, streamlining would be an asset. ICSO customers should be trained in choosing the mode of transportation and be aware of the consequences of an incorrect choice. A selling location cannot require that every ICSO customer follows global nominations. When orders are made in a hurry, weights and dimensions will remain unchecked.

Nominations change constantly. Outdated nomination lists and forwarder information remain in use. The information should be updated, and order desks or logistics teams should correct the forwarders of the orders. **The different time zones** may also cause challenges because the communication between organizations may not be possible and it is not easy to get assistance.

The choice between courier express and economy is not always straightforward. A typical challenge is that the order should be delivered fast, but may not be small enough for express service. SSOs, order desks and logistics teams know the maximum measurements but they do not know packed measurements in advance. The customer service representative chooses a service according to instinct. Couriers have morning and midday services and customers are often satisfied with them. Breakdown orders cause challenges because of their urgency: sales persons, order desks and logistics teams have to combine their efforts to find a suitable forwarder for the order.

If **prices and delivery times are not available**, it can be time consuming to figure them out. If prices and delivery times need to be compared, the logistics coordinator has to check several price lists and delivery times from numerous files and websites. Comparing prices and times takes considerable time.

The list below presents problems related to choosing a mode of transportation and a forwarder. Number 1 was mentioned in several interviews. The first three first were commonly mentioned, while numbers 4–9 were brought up twice and the remaining five only once.

1. Different processes in different locations and excess of options
2. Weight is not known before packing
3. Choosing between transportation options is challenging
4. Suppliers do not book inbound orders correctly
5. Outdated information is in use
6. ICSO orders contain errors (this is linked to no. 1)
7. Checking freight costs takes time
8. Different sizes of orders
9. Human errors
10. Order desk/sales is not expert in choosing the mode of transportation and forwarder

11. Dimensions are not known
12. Checking deliveries is time consuming
13. Dangerous goods
14. Time differences

Based on the list, a lack of harmonization and errors in master data are challenges. Other important challenge is a selection between modes of transportation and forwarders. This may be caused by a lack of updated instructions or knowledge.

5.5.6 Spent Time to Make Transport Decisions

An aim of the interviews was to estimate how much time choosing a mode of transportation and forwarder takes. This would include email and phone conversations with customers, contemplation of the optimal transportation mode, the selection and changes in the transportation mode – if the most optimal mode is not chosen from the start. The interviewees could not give exact numbers for the time spent, because emails often contain other issues as well, which means that it is challenging to separate the time used for choosing the mode of transportation. Time can be spent before the order is placed, when it is being processed, and even when the order has been booked. Pivotal comments from SSO included that choosing the correct mode of transportation is uncomplicated if the order is relatively light, because the correct forwarder can be selected according to weight. If the order is heavy, more time is required to discover the best way to transportation it: will it fit in courier service, or would a truck be a better option? SSO estimated that if an order has to be modified, it takes about 10 minutes – which is a considerable amount of time.

If forwarders for deliveries have to be changed before bookings in DC Trelleborg, the changes take roughly one hour per week. They may take even longer, if the destination is unusual, and the freight cost and breaking points need to be checked. It may take 1–10 minutes, and delay the booking even two days, if the freight cost has to be asked from a carrier. Logistics team in DC Mâcon makes corrections only for about 5% of the deliveries which means that corrections do not take much time there. However, checking the correct forwarder for each order as they do in DC Mâcon, consumes time.

The order desk in DCE has a knowledge of the selection of the mode of transportation and forwarder. If the destination is not familiar, the nomination can be checked from MTG and breakpoints mainly from MRS or MTG. The order desk often asks help from logistics coordinators. The correction of ICSOs often takes a few minutes, because the order has already been progressed, and cancellation of PGI, shipment, or booking might be required.

All corrections can be considered redundant. If a mode of transportation and also a forwarder could be chosen automatically, it would save time for other tasks. Then also human errors could be eliminated. Automatic selection requires that urgency of the order is informed.

5.5.7 Rationality of the Choice

After the selection criteria, the interviewees were asked if they thought that the selected mode of transportation is always the most rational. The answers depended on the location. If the delivery was booked for a forwarder manually after it is packed, the interviewees saw the mode of transportation as the best possible. If the order was standard and a mode of transportation was changed, the change was based on price.

The selection is not always the most optimal. If a forwarder is chosen when the order is entered, the number of problems encountered tends to grow. For the most part, these are **human errors** which can happen under pressure. For example, hazardous material may be booked for a courier, even though Metso Minerals does not have the appropriate contracts with couriers. If the errors are noticed before shipping, they are corrected manually. Occasionally, **an urgent order is not urgent in reality** but the transportation is arranged for an urgent order because the customer merely wanted to ensure that the order will arrive on time.

A truck is occasionally chosen for small orders. This may be caused by an error; however, at times a truck is the correct forwarder for an order. A partial or complete delivery has to be chosen for an order. This means that customers can choose if they want to get all the parts at the same time, or in the order the parts become available. If a partial delivery suits the customer, **post-deliveries** may be formed if all materials are not available at the same time. When an order is divided for several deliveries, the delivery can be light. In these cases, the optimal choice would be a courier instead of a truck. If a small order is delivered by truck instead of a courier, the order may get lost. Other reasons to select a courier is that the freight cost is more expensive and a delivery is slower by truck than by courier. If the order desk has mistakenly selected a truck for the order, but the delivery contains small packages, it is not reasonable to ship by a truck. Logistics coordinators can change shipping for courier if they notice it when they monitor orders. However, at times the error may remain unnoticed. Better instructions for order desks and sales persons on how to choose between courier and truck would be helpful.

At the moment transportation is not selected so that the cheapest and the most suitable mode of transportation are compared as well as needed. At times, a light shipment can be placed on an ocean transportation, while air transportation would be more cost-effective. In addition, if the order could be delivered faster to the customer, the value of the inventory would decrease.

5.6 Challenges of Deliveries

One of the interview questions was: *"What is the role of transportation at Metso?"* An Operational Logistics Team Leader in DC Trelleborg answered: *"Transportation is getting more and more important. People have realized that they can actually save money in transportation. It is not only something that have to do*." Transportation is not only transportation; it is also a way to save money. He was not only one who thinks so. Nearly all interviewees immediately said that transportation plays a significant role at Metso Minerals: it is more than just transportation. Business spins upon inbound and outbound transportation. Without deliveries, products do not reach customers. In other words, deliveries are an essential part of the customer service chain. Presently, transportation is at the spotlight, and it is value added service.

On the other hand, deliveries are not the core competence of Metso Minerals. Nevertheless, they need to be arranged. Despite the fact that Metso has recently focused more on transportation, the company does not yet know enough about it. Price policies and contracts with forwarders are important, because deliveries could be more effective than they currently are. It is should be noted that the inexpensive option is not necessarily the best one, since good service is valued high. Thus, at times it may be better to pay more and get satisfied customers.

Deliveries are the touch base with customers: they are the final step of the order-to-delivery process. The aim is to keep customers satisfied. If everything has gone well until the transportation, but there are problems with the transportation, customers are not satisfied with the process as whole. The delivery at end of the process chain demonstrates for the customer the functionality of the process as a whole. Transportation is an essential part of the process. If material is not delivered, there is no cash flow.

The most important steps of the order-to-delivery process are **how quickly an order can be placed into the system** and how the delivery progresses. Reliability and agreed schedule are the most important things in the process, because information concerning the dates is important to customers. Metso Minerals has **service level agreement (SLA),** which states that Metso Minerals has to deliver MTS orders within Europe in five days. Maintaining SLA can be challenging at times, because many deliveries depart from the Nordic countries. This means that the distances to southern Europe are long. Furthermore, there may be only one or two departures per week to a destination. Deliveries to sparsely populated areas may take a long time. In order to maintain the SLA, Metso Minerals has to pay considerable sums for faraway deliveries. A shorter delivery time would be an alternative. In addition, because the whole chain needs to be synchronized, warehouse operations have to correspond to the schedules. The process speed could be enhanced with extensive use of automation. Furthermore, Metso Minerals should be able to **measure** transportation better but the company is dependent on information from forwarders and customers.

There are several challenges related to transportation. Metso Minerals **cannot control all transportations**. For example, purchasers and inbound logistics coordinators have no visibility to inbound logistics, because bookings are mostly arranged by suppliers. Occasionally, suppliers book an order, but the delivery time is not announced: the only information given is the shipping date. Similarly, in outbound logistics Metso Minerals informs only the shipping date to customers; it can be assumed that customers would like to know the arrival date as well. The forwarder is responsible for the delivery; however, the date can be ascertained if the customer needs to know it. Carter & Ferrin (1996, p. 58–59) give examples of companies who control inbound transportation networks. For example, a company wanted to start selecting carriers for inbound transportations instead of letting suppliers select them (Carter & Ferrin 1996, p. 59). If the inbound transportation is managed by the company, costs could be lowered.

During the process, typical transportation quality problems include **balance errors, delays and disappearances**. The term balance error refers to the situation where material is not available although it should be. At times, the goods do not arrive on time to a warehouse, or customer or a forwarder loses the package. Determining the location of a lost shipment can be time consuming. At times, Metso's contract **forwarders do not provide adequate information** about problem situations in outbound bookings: information is sent late or not at all. Customers regularly complain that parts are late or missing. This indicates that shipments should be monitored better. Information of delivery (IOD) should be transferred to MTG when the order is delivered. Furthermore, a proof of delivery (POD) should be received for a request. Proof of delivery is a receipt signed by a consignee which proves that a shipment is in good condition (BusinessDictionary 2016c). Metso Minerals must demand for the agreed services and if the forwarder cannot offer them Metso should change the nominated forwarder.

Documents for non-EU shipments may not always be available. Communication via email is necessary if, for example, the forwarder asks for customs declaration or an invoice. Invoices to export countries may present a problem. If Metso Minerals sells an order to the Metso SSO or distributor and the order is then sold to an end customer, to whom the delivery is directed, it means that there will be one delivery but two invoices. Both of the invoices have their own required information so the end customer should not receive two invoices. Occasionally, they may receive two, which means that a single invoice should be in use in transportation. Because invoicing is time consuming, there have been attempts to automatize it.

Truck deliveries could be planned with more care. It should be possible to separate part load and groupage deliveries because their timetables at a warehouse are different. Metso Minerals is not aware of the timetables until after a truck company has received the booking. Employees in the order entry team do not know if an order is groupage or part load. Metso would need more options for courier services or a forwarder who could deliver large parts which can be booked late and which should be delivered as soon as possible.

Special orders, such as orders which contains **hazardous material** can be problematic. These orders should be able to send fast by courier. However, Metso does not have contract for it. For the handling of chemicals, safety data sheets are needed. Based on the laws of European Union, the document has to be translated to all the languages of the countries the material passes. The stickers marking the specific packages need to be in all these languages as well.

5.7 Monitoring of Shipments

Delivery reliability, visibility and **monitoring** are not on a satisfactory level in either inbound or outbound shipments. Metso Minerals does not have not reliable suppliers, yet on time deliveries are vital. A monitoring tool has been developed in SAP for DCE. However, by using this tool, orders can be followed only when the goods are in the warehouse. When the order has left the Metso Minerals warehouse, visibility disappears. MTG is a useful monitoring tool, but there is always room for improvement. If the order is booked in MTG, it is generally well monitored. In the rest of the cases, monitoring is not as straightforward.

In inbound logistics, MTG is more used for transportations within the EU than for bookings made outside the EU. If the **supplier does not use MTG** and books orders by email, the supplier may send the booking email to the purchaser as well, so that the purchaser can see the booking details immediately. Even if the order is booked in MTG, **all nominated forwarders do not** send, or cannot send **status updates back to MTG**. Thus, the status has to be checked by using a tracking number on the forwarder's website. The tracking number can be checked from MTG or occasionally from SAP.

MTG is a tool that is mostly used by logistics teams; however, other teams could benefit from its use as well. The purchase team occasionally uses MTG if they need to track something. The order desk can check tracking numbers, nominations and delivery time in MTG. SSOs check delivery statuses and tracking numbers from MTG, which means that they do not always need to contact the logistics team. In all Metso locations, MTG is used for outbound bookings more often than for inbound bookings. For example, MRE Düsseldorf uses MTG in inbound bookings for a single truck company. In comparison, MRE Düsseldorf uses MTG almost for all outbound shipments, excluding taxi services. The majority of outbound bookings in DCE, DC Trelleborg, DC/SSO Mâcon, Domestic Sales in Finland, and SSO in the UK are made in MTG. Manual bookings are occasionally made in MTG as well. At times, manuals and shipping documents are booked via MTG: this means that there is no order in SAP. In summary, MTG is mainly used for:

- bookings,
- checking a tracking number of a shipment,
- following a status of a shipment,
- calculating a delivery time,

- calculating a price of a delivery, and
- creating manifests.

In those bookings that are arranged and controlled by Metso Minerals, the monitoring of shipments is easier that in **the shipments arranged by the customer**. The latter are not Metso Minerals' responsibility, but the company nevertheless receives questions about them. Urgent shipments are monitored manually. However, a better tool for monitoring would be needed. In addition, it should be easier for customers to follow orders than presently is possible. Several customers see the tracking number either in SAP or on an invoice. They can track their shipment either in MTG or on the forwarder's webpage. End customers should be notified when the goods leave the warehouse. Also, the customers should be given the tracking number so that they can follow their order.

Customers do not always receive the order on time. **The customer is often the first who knows that the order is late**. Proactive communication concerning the delays should be improved. Presently, this is not possible because if there are problems with the shipment, forwarders do not generally inform about its status. Metso Minerals should be able to tell its customers how to follow their shipments. One or several interviewees in every location mentioned that it is difficult to get confirmation on when the goods will be delivered.

5.8 Cash Flow of Transportation Costs

EXW, FCA, CPT and DAP are the most common incoterms used by DCE. The freight costs may be charged based on the incoterms.

- EXW: A customer decides a forwarder and pays freight costs. Metso is not responsible for arranging the delivery. However, occasionally Metso can book the transportation order as an extra service to the customer. The customer or the forwarder makes an export declaration. This incoterm does not cause any transportation-related costs for Metso. Metso has decreased the use of this incoterm.
- FCA: Either Metso or the customer arranges transportation and Metso is responsible for the export declaration. Freight costs are addressed to the customer by the forwarder.
- CPT: Metso arranges transportation to a port and offers or purchases an export declaration service. The customer organizes a delivery from the port to the final destination. Metso charges freight costs by adding them into a commercial invoice.
- DAP: Metso arranges transportation, and charges freight costs on an invoice. Alternatively, freight costs can be included in the parts, according to a certain percentage. If freight costs are included in the price of the parts, however, special transportation services are nevertheless charged separately.

When Metso Minerals pays the freight of inbound shipments, the costs can be included in the price of the goods, or charged separately. Metso Minerals uses mainly FCA and DAP incoterms in inbound deliveries. The pricing policy depends on the unit: there is no uniform model for charging the freight costs. Harmonization of the models could increase the cost-efficiency of the company. Figures 5.8.1., 5.8.2., 5.8.3., 5.8.4., 5.8.5. and 5.8.6. present how freight costs are handled in basic cases in all locations where interviews were arranged.

In Domestic Sales in Finland, the freight costs are invariably charged from the customer if Metso Minerals pays the freight to the forwarder. In a default situation, the customer's account is used for bookings. This means that FCA Tampere is the most general incoterm. However, at times the freight invoice is sent to Metso Minerals, and Metso Minerals charges the freight from the customer on an invoice. If Metso Minerals charges freight costs and adds those to the invoice, invoicing is based on Metso's contracts. If Metso Minerals pays the freight costs and charges them from a customer, the freight costs are checked from the forwarder's webpage, or freight costs informed by DCE are used. The freight cost is never checked from MTG: this could be a target for development. Customers know that urgent orders may be more expensive. If the order is late or there is a problem, Metso Minerals pays the freight costs on behalf of the customer. Domestic Sales believe that Metso Minerals should use more CPT or DAP, and the freight could be sold as a service. This would mean that freight contracts could be better, and freight costs lower, compared to the cases where customers pay the freight. Figure 5.8.1. presents how Domestic Sales in Finland charges freight costs from customers.

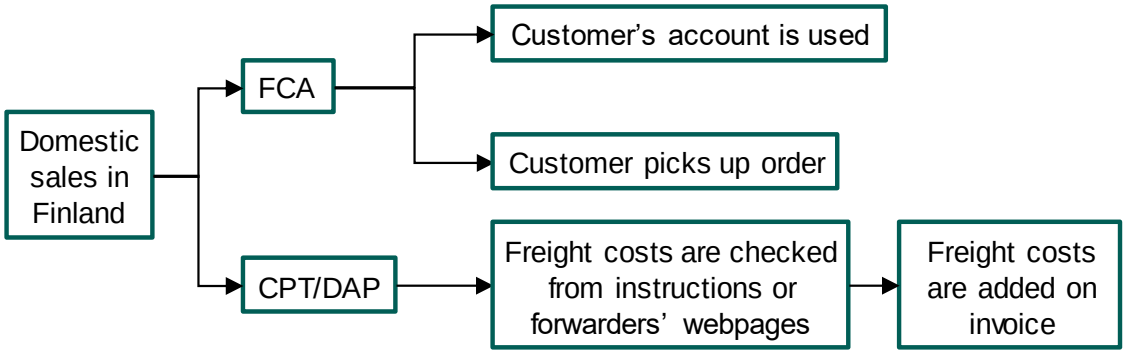


Figure 5.8.1. *Freight invoicing process of Domestics Sales of Finland.*

In SSO Mâcon, freight costs are charged differently from end customers located in Europe and customers in export countries. The differences are shown in Figure 5.8.2. In France, solely freight costs of breakdown and express orders are charged. If the value of the sales order is over the certain amount, the freight cost is not added for standard deliveries to France. If a specific equipment or other special arrangements are needed, they are charged from the customer. Freight costs of shipments to export countries are linked to an incoterm. For example, in CPT the freight cost is added on the invoice. If DC Mâcon orders from DCE, and the delivery is to an end customer, DCE charges the price of the delivery,

whereas DC Mâcon charges an amount from the end customer. DC Mâcon sells transportation as a service; the unit does not charge for it. The freight cost is charged on the same invoice with material. It is checked and added on the invoice manually.

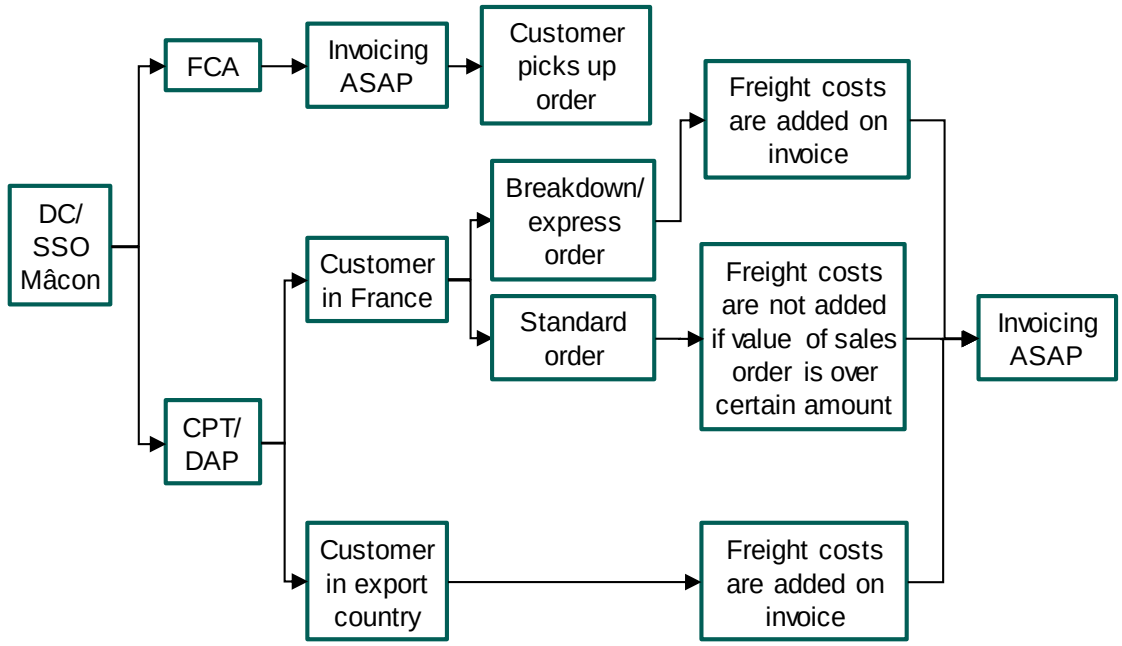


Figure 5.8.2. *Freight invoicing process of DC/SSO Mâcon.*

UK has DAP pricing in every location where they are order ICSOs from. This means that the price of a delivery is included in the price of the ordered parts. SSO UK charges freight costs from end customers during invoicing if the freight costs are already known. Freight costs are charged solely in breakdown orders. The invoicing process is presented in Figure 5.8.3.

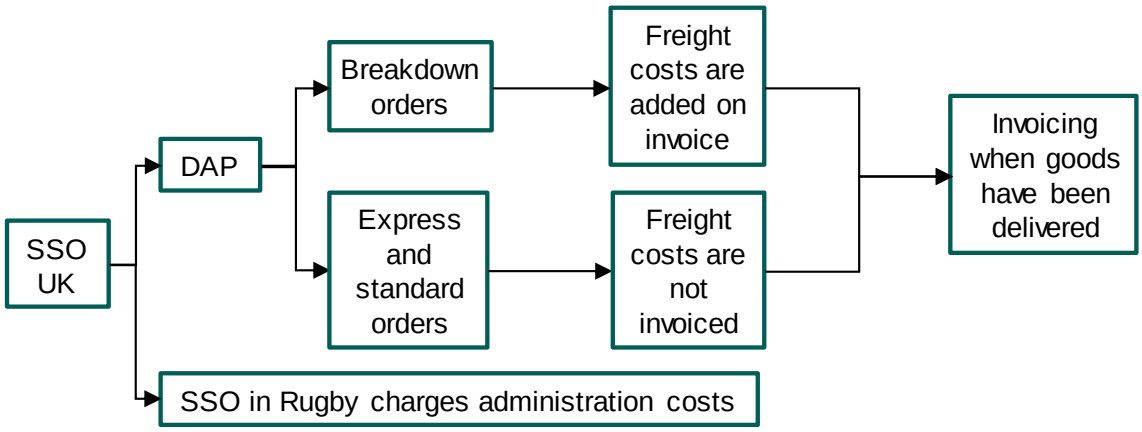


Figure 5.8.3. *Freight invoicing process of SSO UK.*

MRE Düsseldorf uses mainly incoterm FCA for shipments to continents other than Europe. An order is booked using the customer's account in MTG. Freight invoices are sent directly from the forwarder to customers – which in overseas shipments are mostly Metso

units. Export orders are invoiced as soon as possible because the invoice is required for the export declaration.

DAP pricing between Metso units is mainly used in Europe. If customers make requests concerning the mode of transportation, for example a courier for a heavy shipment, they have to pay for it. Freight costs are charged, if a delivery is not arranged as per the manual; special transportation is always invoiced separately. Customers located in Germany are sent the invoice two or three days after the order has left from the warehouse to make sure that the invoice will not arrive before the parts have arrived. For certain customers, 100 per cent payment in anticipation is in use. Figure 5.8.4. presents how MRE Düsseldorf charges freight costs from their customers.

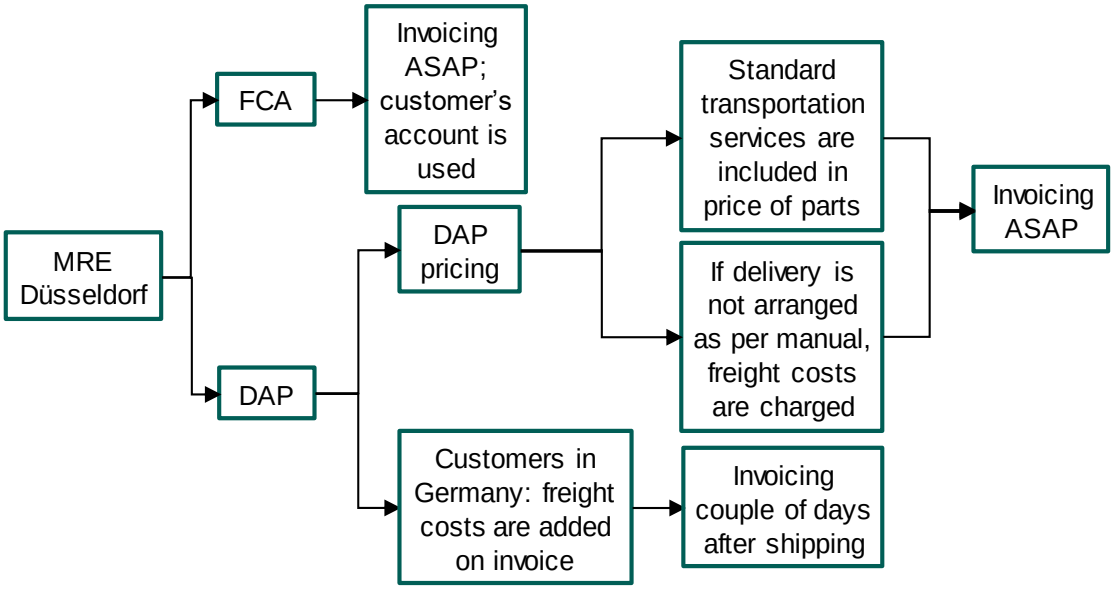


Figure 5.8.4. *Freight invoicing process of MRE Düsseldorf.*

FCA and DAP are the most commonly used incoterms in Metso Minerals Trelleborg. Distributors use mainly FCA when they pick orders up themselves. Export deliveries are also FCA-based. The logistics team often arranges the delivery and uses the customer's account for a booking. If Metso arranges a delivery and pays freight costs, DC Trelleborg adds freight cost on the invoice. DAP pricing is used for several internal customers within Europe and in Sweden when the freight cost, which is the certain percentage of the price of material, is included in the price of the product and it is not added separately on the invoice. This DAP pricing is used only for standard deliveries, which means trucks or couriers in Europe.

If Metso Minerals pays the freight costs for overseas shipments, the logistics department adds final delivery costs to the delivery. This cost is visible on the invoice. In addition, the customer pays for special transportation which are mostly booked for breakdown orders. In DC Trelleborg, an express order is a breakdown order, but the parts are immediately available, and the order is delivered by a courier. For DAP pricing customers, the

freight costs are included in the price of the materials. If DAP pricing is in use and the standard delivery is arranged, the freight of breakdown orders is not charged from the customer.

Invoicing is a manual process. Freight costs are added on the invoice; separate freight invoices are not made. PGI is done when a forwarder has picked up the goods for cargo within Sweden or EU. Following PGI, an invoice can be made. If an invoice is needed for export clearance, PGI is made beforehand. The export document fee is included in the price of the goods which means that it is not charged separately. Export declaration service is ordered from an external company. The charging of freight costs in DC Trelleborg is presented in Figure 5.8.5.

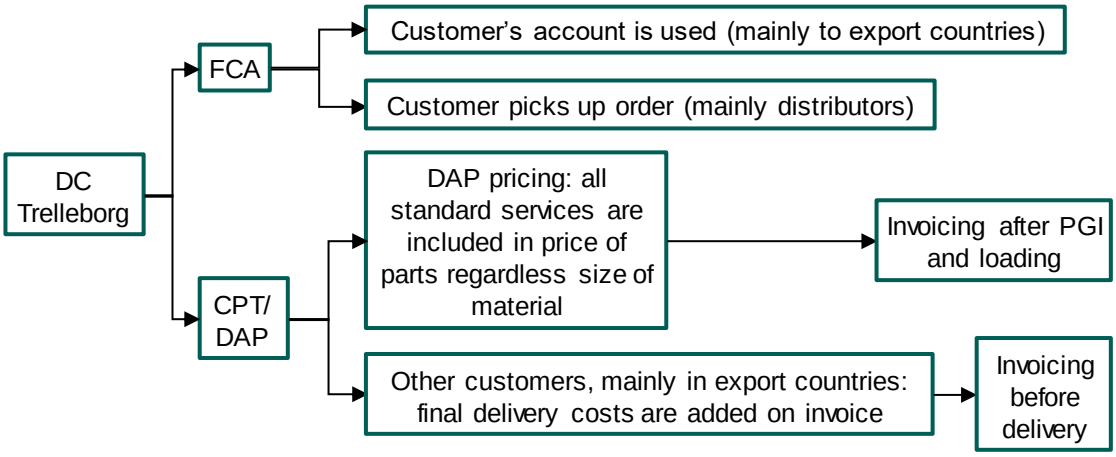


Figure 5.8.5. *Freight invoicing process of DC Trelleborg.*

DC Europe has EXW and FCA shipments when a customer picks an order up at the warehouse or Metso Minerals arranges a booking by using the customer's carrier account. In addition, DAP pricing is in use for certain customers, for both SSOs and distributors inside and outside the EU. DAP pricing percentage depends on the customer. If DAP pricing is not in use and Metso Minerals pays the freight costs, Metso Minerals charges the costs from the customer on a commercial invoice or separately on a freight invoice if freight costs are not known when the commercial invoice is sent. The freight costs are mostly checked from MTG or MRS. At times internal calculators are used, despite the fact that they may not have been updated. Thus, incorrect freight costs may be charged from a customer.

The mode of transportation is chosen according to the delivery priority and weight. If a heavy order is placed for a courier service, there are no extra charges. Special modes of transportation, such as taxi service, are charged separately. Figure 5.8.6. presents a process of invoicing freight charges in DCE.

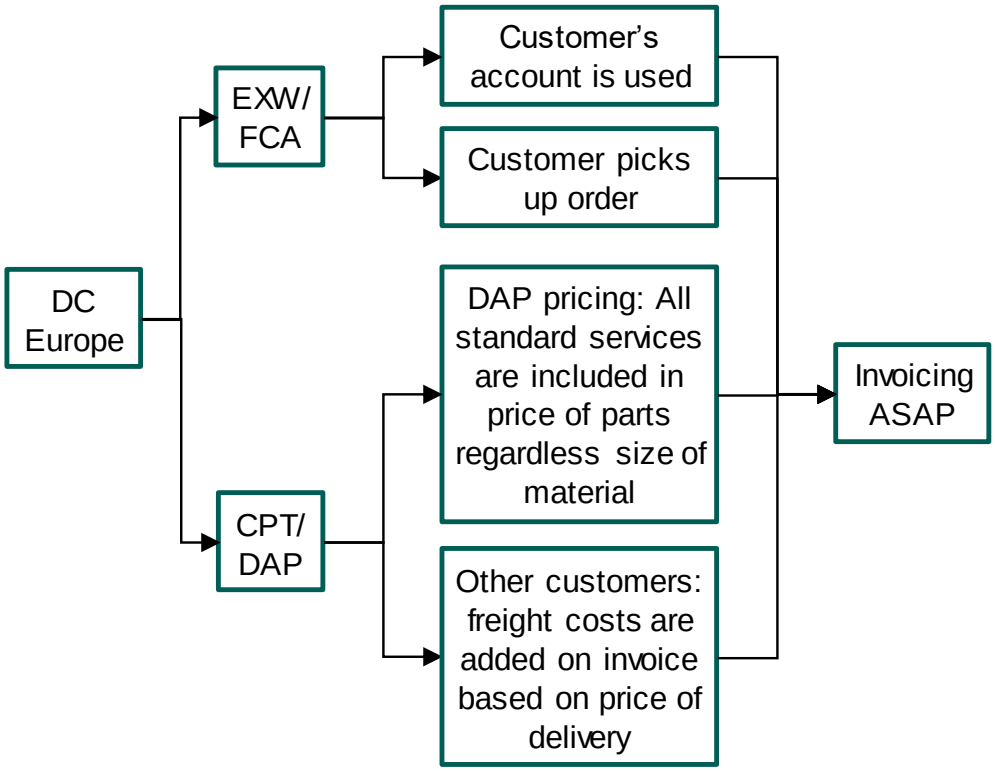


Figure 5.8.6. *Freight invoicing process of DCE.*

If an order is late in any of the units, every incident is checked individually. Occasionally, Metso Minerals may offer freight costs for special transportation such as taxi. In addition, Metso Minerals pays freight of free of charge (FOC) shipments. If taxi or other special transportation is needed, in the majority of cases the customer pays the freight costs, even if DAP pricing is in use.

ICSO invoicing process is the same in every location. In inter-company sales orders, the sales and service office has to charge first the freight cost from an end customer, after which the selling location can charge the buying Metso unit.

5.9 Warehouse Operations and Packing

DCE has almost 20 000 different items in warehouses. Customers may order one item, or several items together. This means that there is a great amount of **variation in packing** orders. However, high quality packing remains an important factor.

This chapter focuses on ways how to pack for each mode of transportation. Time spent for the packing of orders varies. In addition, challenges of warehouse operations will be handled.

5.9.1 Packing Depends on the Mode of Transportation

There are numerous ways to pack orders. Warehouses have stackable and non-stackable packing materials and parts, pallets, collars, covers, plywood boxes and cartons. Warehouses have manuals which should be followed. Orders should be packed so that there would be as few collies as possible per a delivery.

A few of the interviewees think that it is essential to know how an order will be delivered in order that a correct way to pack can be selected. Others, however, think that it is not essential. A few think that a generic mode of transportation has to be known but there were also comments that the forwarder needs to be informed for the warehouse operations as well.

The greatest distinction is that ocean shipments are packed differently from packages used in other modes of transportation. Rules and common sense should be used when packing to other modes of transportation. According to Karjalainen & Ramsland (1992, p. 212), in many respects, the handling of material is similar in all modes of transportation. Courier and air freight shipments are packed as light as possible to keep the costs for customers low. No extra packing material is used but sufficient packaging must nevertheless be guaranteed. In other respects, packing for truck is similar to packing for courier and air.

If the mode of transportation is not known, the warehouse has to pack an order to withstand the most challenging mode of transportation: ocean freight. This may lead to **overpacking and wastage of packing material** if the order is not delivered by sea. Orders for ocean deliveries are packed differently, because vapor corrosion inhibiting plastic and wooden boxes are required. Packing material for ocean deliveries is more expensive than, for example, carton boxes. Transportation contracts have an influence on deliveries as well. If the order is overpacked in a wooden box, instead of a carton box, it requires more space and weighs more in transportation. Packing in carton would be cost-efficient, because packing material is used less and the package is lighter, which lead into reduced transportation costs. Metso Minerals can optimize the forwarder by using packing material which can be used for all modes of transportation. This would mean that packing material would probably be safer – and heavier.

Shipments in all modes of transportation, excluding ocean shipment, could be packed almost in the same way. Schedules would be the next issue in warehouse operations. At the moment, route schedules in SAP depend on the forwarder and country, and they define the timetable of the order, which is followed by the warehouse. If the mode of transportation is unknown, routes cannot be used. This means that the warehouses face the challenge of prioritizing the packing of orders; they need to determine when each of the orders should be packed. When packing orders, the Born warehouse checks the delivery priority as well. If the mode of transportation is not known, it will require more time to pack urgent orders.

DC Trelleborg packs the products with care which has both pros and cons. The packages look good and the Metso brand is clearly visible. Naturally, the expenses grow as well. In DC Trelleborg, there are few changes in the way of packing that depend on the mode of transportation. This means that it is easier to make changes in the mode of transportation. Because the packages are nearly the same for all modes of transportation in DC Trelleborg, deliveries could be packed without the information about the mode of transportation. However, this could mean that pick-up times might be challenging.

The size of material is not the only determining factor in packing. For example, ICPOs may include small packages but they are still delivered with other packages by sea under the same waybill. An important question is how communication would work between Metso Minerals and a warehouse, if the mode of transportation were chosen after packing. The warehouse should transfer the order to a correct shipping lane after the order has been packed. Moving the order to the correct shipping lane should not cause problems or additional costs compared to the savings in transportation costs when the optimal mode of transportation is used.

5.9.2 Challenges of Warehouse Operations

For the most part, errors in warehouse operations are related to the following issues: **damaged parts, delays or errors in goods receival, inventory discrepancies, long ODR handling times, delays in pick and pack, picking errors, wrong packings, delays or errors in loading or parts lost during inbound or outbound process**. The errors may be caused by various reasons. For example, errors in goods receival could be a result of labeling errors, if material is damaged and it cannot be sold, systems errors and documentation errors, for example, if packing lists or other export document is not correct. A labeling error means that an incorrect sticker is attached to the part. If a part does not have a label, the warehouse should find out what it is, to ensure the right handling and prevent wrong items from being sent to customers.

The interviewees who place orders said that **cut-off times are not flexible**. It may be vital to get a breakdown order to leave on the same day when the order is placed; however, if the cut-off time has passed, it is not possible to send the order. It is possible to negotiate special arrangements with the forwarder and the warehouse but they should be able to enter into the system as well.

An observation apparent from the interviews is that a warehouse requires excess time for handling of orders, especially in putaway, picking and packing processes. If a putaway has not been done, materials are not available. Invariably, there are a few delays in warehouse operations. However, urgent orders should be handled faster. Suppliers should use, for example, stickers which ensure that the warehouse notices urgent materials. Warehouses should inform orders desks or logistics teams about delays. In addition, any problems should be brought into attention. Smoother communication between Metso Minerals

and a warehouse would help in many situations. One of the problems with communication is that if the forwarder is changed, only the customer service of the warehouse receives the information, whereas warehouse operations do not.

Warehouse personnel would need instructions and training to ensure that orders are packed correctly. The instructions and trainings should include information about the correct packing material for each item, the mode of transportation, and the correct way to pack items. In addition, the warehouse employees should be made aware of the possible results of incorrect packing. Keeping exact manuals is not possible at Metso Minerals because of the number of products. At times, the **packing information is not entered correctly** into SAP: this causes problems with bookings and transportation. Incorrect information may mean wrong measurements, weight, or wrong labeling. If the orders are not ready on time, but have to be on site as planned, special arrangements between the customer, DC, warehouse, and forwarder are needed.

More attention should be given for the planning of **loading and unloading areas**. For example, the warehouse in Born has both inside and outside areas. The outside area at the Born warehouse is one-way: if there are several trucks coming to load orders at the same time, the waiting time can be long. If loading and unloading take a lot of time, forwarders may add extra costs. Drivers can cause problems at a warehouse, if they do not know what they are coming to pick up, and **do not have a pick-up reference**. In addition, EXW and FCA shipments, which should be collected by the customer, may **not be picked up** from the warehouse so they take floor space for a long time.

Different mistakes may happen at the loading phase. The loading can be prolonged or incorrect. A loading error refers, for example, to situations where wrong items are packed, or wrong pallets are loaded into trucks. If the order is not sent correctly and, for example, a part is missing when the order arrives to the customer, the investigation can take a considerable time. The first step is to solve whether the part has been sent to another customer, or if it still is at the warehouse. If another customer has received the part, the order usually needs to be returned to a warehouse, and shipped again to the correct customer. Several similar examples of incorrect packing could be given. In addition, it can cause problems if a portion of the packages of a shipment leave at the warehouse. With care and adherence to the schedules, it could be ensured that parts are not damaged in shipping, or shipped incorrectly.

Returning shipments are a separate process, which is not taken into account in this thesis. The return may happen because of incorrect delivery, such as a wrong part or quantity. The delivery can also be made to a wrong address, or the shipment can be late or missing. In these cases, it may be that a free of charge (FOC) order is sent to the customer while the original delivery is shipping, which might mean that customers receive their order twice.

5.9.3 Used Time for Packing

The contract with the Born warehouse used by DCE and MRE, mentions that the warehouse has a certain time limits to pack orders. The limits depend on the urgency of the order. Further critical time limits, such as the time when the order has to be packed and loaded, come from the routes in SAP. In addition to the Born warehouse, other warehouses use routes as well. The actual time of packing is not necessarily the scheduled time, depending on if the warehouse pays more attention to the routes that to hour based time limits. Transportation time and date have priority, followed by the contracted times for breakdown, express and standard orders.

In DC Trelleborg, the warehouse picks and packs the orders mostly on time. When the volume is high, the warehouse may not always be on time. Thus, DC Trelleborg works with pre-bookings by using master data of materials. However, all information may not be known beforehand, for example if the package is stackable or not.

5.10 IT Systems

IT systems are obligatory in modern companies. Without them, the processes would be slower and Metso Minerals could not reach the SLA. Cost-effectiveness is partially a merit of IT. If the systems do not work correctly, they may cause considerable harm for the company.

In Metso Minerals, SAP shipment data is transferred to MTG by sending messages using EAI services. Electronic messages pass in both directions. There are many fields in SAP with a counterpart in MTG. In addition, data from MTG is transferred further to forwarders' systems.

5.10.1 Rigid Systems

Metso Minerals' **inbound order process is challenging for suppliers**. They should use P4T to confirm orders and MTG to book deliveries. However, **the systems are not integrated** or even used via interfaces. In order for suppliers to be able to use P4T correctly, instructions and orientation should be provided. There are MTG templates for suppliers to ease the booking of shipments. At the moment, there is a surplus of templates because a portion of them are not valid anymore and should be updated. All suppliers should have access to all possible templates that they can use, and the information they contain needs to be correct and exact to reduce mistakes in bookings.

P4T and SAP are rigid systems. **Non-agile systems** are one of the challenges**.** If one of the order lines has incorrect information, the whole order may become blocked. If data does not go through to SAP, all lines will be physically at a warehouse, but the warehouse cannot receive any material of this order in systems. A few import orders are easy to

receive, but others may require clearing: for example, there may be no packing list attached to an arriving package. This is a sizable problem, which will need to be improved, and which also reveals how rigid systems can be.

MTG should have more features, and be easier to develop. Forwarders often send loading lists, which increase **the amount of emails and manual work**. MTG offers manifests which are useful for forwarders; however, warehouses cannot get loading lists from MTG.

5.10.2 Errors in Systems

In SAP, several issues may cause obstacles in an order. The most common challenges are incorrectness of **master data**, **human errors and differences in placing an order between different plants**. Order desk is usually responsible for a maintenance of the sales area data.

Master data, such as the net weight or customs code, in SAP may be incorrect. If there is a wrong value, it goes through automatically to an order. Human errors and lack of knowledge cause mistakes as well. For example, a wrong field may be ticked in the special processing ID, which defines a payer of freight. If the ID is at variance with the incoterm, the order may not be shipped. All human errors do not affect the systems. However, they may not be linked to customers' requests. The quantity may be wrong, or the price of freight may be incorrect. If there is something wrong with the order, employees can check the incompletion log. Unfortunately, all human errors are not visible in the log. SAP may accept an order even if there are problems with the order which may cause problems at the end of the process. Different plants act in different ways, which may cause problems as well: orders are not always placed correctly. While the system has a same base for placing orders to each location, in practice the system is used differently in different locations.

Errors can occur when data is transferred, for example, from SAP to MTG. One reason is that messages do not pass the whole chain. The solution depends on the error and the duration of the break. If the problem is not solved soon, the order can be booked to the forwarder by email. There may be **errors in MTG** if the payer information is not clear, the ship-to address is incorrect or unclear. In addition, the dimensions can be missing or incorrect. For example, the size of the order can larger than the forwarder can handle, or is stated in the contract. These situations are caused by errors in the ordering stage. If MTG does not work, bookings to the forwarders have to be made using emails and other manual methods. Furthermore, if SAP does not work, several processes at Metso Minerals are stalled. All parties should receive information about errors as soon as possible.

5.10.3 Opinions of Automation

Of the interviewees, 50 per cent think that automation increases reliability, whereas 14 per cent believe that automation increases unreliability. The rest, 36 per cent, think that there are pros and cons in automation. Arguments in support of automation emphasized its tendency to speed up processes. If it works correctly, automation can reduce manual work. If information is entered correctly, it is reliable. Thus, for example, the data in MTG can be relied upon – in theory at least. In addition, the risk for human errors is reduced. If users enter wrong information to an order in SAP, it may be that the order is not shipped. The experience has been that auto-PO process works well, and the purchase requisitions are correct. Automatic release of blocks is satisfactory and quicker than a manual PO process. From the service point of view, ICSO process is quite useful; it is also easy to follow. Certainly, monitoring is needed, but it has several positive qualities.

Initially, automation may be challenging because employees might feel that they lack control. According to the interviews, employees want to be able to control things. However, only one of the interviewees said that the decisions should be left for employees. Final decisions, at least, need to made by people instead of machines. Visibility may be less clear during automated decisions: this may be the reason why interviewees think that they are losing control. On the other hand, this may cause errors, which is why careful monitoring is required. A way to accomplish this could be, for example, an automatic email that is sent when the goods have been scanned to truck. It is more challenging to fix issues after the goods have left: manual checking is needed at least in the initial stages of the automation and in the testing phase. Exceptions of any kind present one of the greatest problem with automation. It should be measured the amount of time automation saves by examining the process before and after automation.

Automated processes require that data is correct and updated, orders can be monitored, and the automation is well-planned. Automation has to be done carefully and documented well. The documentation needs to be detailed and cover all the phases. After everything appears to have been documented, automation can be implemented. Automation should be carried out in response to customer requirements; otherwise implementing new processes is not reasonable.

A few of the interviewees mentioned that automation means a change in thinking and working, including adjusting to the perceived loss of control. Trust in the system increases when automation is in use and it works. A few of the locations have been extremely controlling in the past but currently, the trust in systems and automation has increased and work has become easier.

5.11 Operations which Take Unnecessary Resources

In conclusion, the order-to-delivery process should be accelerated and harmonized. The amount of manual work in the process would need to be lessened. However, the process in DCE is quite highly automatized. It could be automated further, and tested automated processes should be adopted in other locations as well. System errors may naturally occur, even if the systems are trustable. They may be caused by the system itself, or by the integration between systems. Bookings are vulnerable during system errors. Automation can be susceptible as well.

In the interviews, the issues in the order-to-delivery process which consume the most resources were taken into consideration, revealing the development targets in the process in detail. Master data and amendments are mentioned often in the interviews: indeed, they are linked together. Other issues that were mentioned included manual actions: in other words, actions which could be automated. In addition, monitoring orders consumes time and systems are rigid. Searching for lost shipments also requires resources. All of the issues mentioned above could be improved, or replaced by more reasonable actions. In addition, customer service may be time-consuming: it would be more efficient if customers could check basic facts from the system. In the following, less frequently mentioned issues are presented. Challenges may occur, if parts which are needed immediately are not available. In addition, credit blocks may cause unnecessary delays. Checking prices for air and ocean shipments is time-consuming, because prices are not collected to a single location. The prices should come from the tender or be printed directly to an invoice. While booking is a swift process, it nevertheless may take time if there are several bookings per day. In addition, the handling of documents, such as sending invoices and saving export declarations, should be done in a more reasonable manner. At the moment they are made manually.

The aim is to optimize each stage little by little. A frequent issue which consumes time is the need to wait for answers and send reminders for stakeholders. Each party should be required to answer emails within a time limit.

6. DEVELOPMENT IDEAS

The frequency of responses in the interviews contributed to the development suggestions. If an issue is repeated in answers to different questions or if several of the interviewees gave similar answers, it means that the issue would need to be improved.

This chapter discusses with development ideas based on the structure of Chapter 5. The development suggestions for information flow, material flow, ordering process, choosing a mode of transportation and forwarder, deliveries, warehouse operations, automation, and cash flow will be presented below.

6.1 Development of the Information Flow

While the information flow inside the organization is seen as satisfactory, the majority of the interviewees found need for development as well. Within Metso Minerals, all employees should have access to the newest information concerning the company. **Communication** between people is perceived as important. **Databases containing general instructions** should be available for every employee. They could, for example, contain information about public holidays in different countries. In addition, **training** can be used as an information channel. Figure 6.1.1. presents the areas of information flow which need to be developed. Naturally, **continuous improvement** should not be forgotten either because changes must be made to meet changing needs.

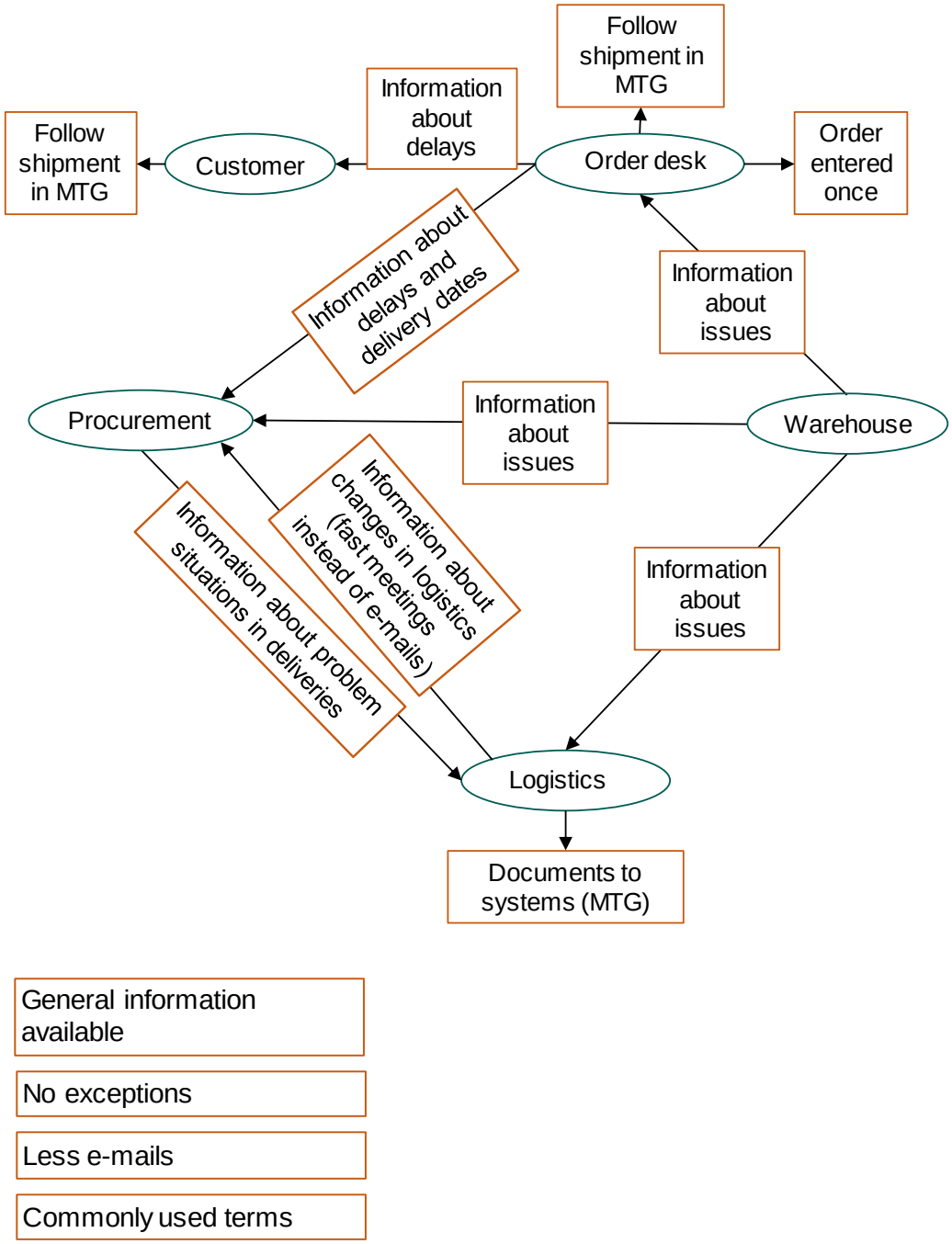


Figure 6.1.1. *Development targets of information flow.*

The starting point is that **the end customer should give all the required information** immediately, so that the order needs to be entered into the system only once. It would save time if the order desk or sales person would not need to ask clarification from the customer. When the procurement team has ordered materials which will not arrive on time, the team should **inform** the order desk **about delays** or the delivery dates. Thus, the order desk or sales person can inform the customer about the possible delay. In addition,

the logistics team and supervisor may receive information about possible issues. **Information should flow smoothly** from one party to the next during the process. This means that all required information should reach the correct party.

If there are any changes in processes, teams should arrange **ad-hoc meetings** and tell about changes to other teams. If a warehouse faces problems, they should immediately inform the procurement team, the order desk or the logistics team about the problem. The logistics team should be able to **upload documents to systems** for the use of all parties. This would reduce the need for email communication. Thus, the system could serve as a repository for various documents. In addition, orders and order confirmations could be sent via systems. Presently, Metso Minerals' workers send numerous emails. This may lead to vulnerability if an employee becomes ill or leaves the company.

Emails are a common tool for communication. Each employee in DCs and SSOs receives several emails every day. In order to be able to concentrate on the important emails, **employees should be able to perform basic operations on their own**. Several actions would consume less time if the employee could take care of it directly, instead of writing an email to another employee, not to mention the time that may be lost before the recipient has time to read the email and comply with the request. An example of a basic operation is checking the status of shipment in MTG. In the majority of the cases, the customer, the sales person and the order desk can check the current status of the shipment in MTG, provided that they have an authorization to the system, which many of them have. Furthermore, the order desk could check the freight costs directly from the system and so to reduce the amount of emails.

Because exceptions tend to increase the workload and cause errors, their amount should be decreased. Another important development proposition is **the standardization of terms** in all units. Information flow is smoother and confusion does not occur when terms and services are named consistently. All abbreviations should be listed in a single place. In addition, **workable practices should be shared between units**, because many DCs share customers and operating models.

6.2 Development of the Material Flow

Material flow is different for MTO and MTS parts. Table 6.2.1. demonstrates possible improvements for each challenge in a chronological order.

Table 6.2.1. *Challenges and proposed improvement ideas of material flow.*

Challenge	Improvement suggestion
Excess of suppliers, all materials are tendered	Fewer suppliers and higher volumes from the chosen suppliers. Thus, consolidating materials from suppliers is used more and communication is easier.

Long response time	Guidelines for response times
The balancing of material between warehouses is not always rational	Storing of inexpensive and small parts in all the warehouses
Material is not available in a correct warehouse	Parts could be in warehouses in proportion to demand instead of machine types
Item opening, lead time and processing time are lengthy	Item should be opened before the sales order so that an order could be shipped earlier. Putaway should be faster.
Repacking	Identification of materials which are often ordered to a warehouse and sent to a customer in the same assembly
The delivery time is lengthy	Faster chains with less hubs of forwarders. More direct deliveries.
Freight costs are expensive	Carefully selected forwarders. More direct deliveries.

These development ideas will need further investigation before implementation. If an idea is implemented as it is presented in the table above, other issues may occur. For example, direct deliveries may cause too much work compared to its benefits. Further investigation falls outside the scope of this thesis.

6.3 Development of the Order Process

The main issue with ordering is that Metso has several DCs, and sales people may not always know what they should order from which DC. Currently, sales people need to know which DC offers which parts. A development idea for harmonization could be that there would be a single interface for ordering from any DC, in other words, **a single order desk**. At the moment, each DC has its own processes and nominations. Each unit wants to control its own technology: because of this, Metso Minerals has several order desks in Europe. Sales people should be able to order only from one order desk, and it would send the order internally to the correct location. The responsibility of the whole process should be concentrated, and there should be no overlap. Customers should not know where the parts are shipped from. On the other hand, this complicates the assessment of the delivery time.

Metso units should operate in standard ways. **Harmonization** of processes would facilitate the understanding of the processes. At the moment, there are different ways to type a same kind of order. It is important that all steps are made correctly. This is one of the reasons why the choice of transportation for every DC in Europe should be standardized. This would mean that the people who place orders would know how to operate in general,

and they could make all orders for all plants in same way. Another solution could be that **orders were filled automatically** to the furthest extent possible, and the risk for human errors would be lowered. **Templates for different order types** might be a useful solution. **A checklist** should be offered to anyone who creates orders.

An idea crucial to improvement is that the **order should be entered into a system only once**. Currently, the end customer either calls or sends an email listing the required parts. Next, the sales person receives the order and enters it into a system, or sends it by email to the order desk, where the order is entered into the system. If the sales person could place the order directly to SAP, human errors, misunderstandings, and extra work would be reduced. In addition, the **ISA ordering** possibility should be available to more customers as it presently is. Thus, messages would be forwarded to SAP in the same form they are entered to ISA. All possible manual steps of the processes should be **automated** to decrease the amount of human errors. This means that monitoring should be improved. For the possible remaining manual phases, a check list should be provided to assist in placing orders. Another way to eliminate human errors could be to have **the systems prevent as many errors as possible**. All the ticks must be in place, and the systems will check for any contradiction and deficiencies. Thus, errors could be weeded out in advance.

Metso should provide **service concepts** for deliveries. Customers should be able to choose if they need a standard delivery or a faster and more expensive delivery. The delivery time for each service should be available in advance. The information should be accessible during the ordering step. If the material is available and shipped on time, there should be no reason to change the delivery priority.

Material availability is one of the factors affecting whether the customer will receive their order when it is required and as it has been promised. Material should be available on time: if it is not, the relevant party should be informed about the delay. Metso Minerals should be more **proactive** and inform the customer immediately when it is known that the purchase order will be received late or that a production is late. Moreover, redundant steps should be removed. For example, **goods should be available directly for DC after they have been produced**. Other units should follow the example of DC Trelleborg and adjust their processes so that there is no need to place an order between own locations. The physical location of the product could be determined with the help of accounting. **Orders** and their deliveries should be scheduled with more care, so that they would be on site **at the same time with service engineers**.

Accelerating the process is crucial and can be done in several different ways. The elapsed time between the arrival of the order to the order desk and the time the customer service representative sends an OA should be shorter. Shorter lead times for MTO parts are vital as well. In addition, it is important that the lead times for breakdown orders were shorter. A possible solution is that materials would be standardized because several Metso

Minerals' products are unique. Also a putaway should be developed faster by improving inbound operations in warehouses. In addition, the putaway could be faster if suppliers used appropriate documents in packages and information regarding to the material were filled in or material data and master data were correct in SAP. When material is available, the price for a delivery and the delivery time should be available sooner than they are now. If the master data were correct, Metso could start working with automated data from warehouses to the forwarders. The data could give information on the types of orders will be sent. With these actions, quotations and orders can be placed faster.

Rescheduling means the changing transportation date and time in SAP if the material is available earlier than originally planned. Rescheduling is already in use in ICPOs and STOs. Rescheduling should take place in the delivery forming phase, not only in an order forming phase. With partial orders, the schedules could be checked line by line. If an order has to be shipped in complete, only the schedules on the order level are checked. If Metso Minerals were to use rescheduling globally, the benefits would be immense. Presently, the purchasers and customer service representatives check from the EA list manually orders that arrive earlier than schedules. However, if rescheduling were in use, one of the challenges would be finding ways to keep the order desk informed about any changes. If a purchase order is late, the order will probably be late. Rescheduling would also postpone the delivery dates, instead of only advancing them. The frequency of the automated run is one of the issues. If a faster delivery is not wished, the first date should not change.

In addition, **the terminology should be coherent** because the present vague terminology may lead, for example, to the use of wrong forwarders. The terms could be listed and defined in intranet.

6.4 Better Way to Choose the Mode of Transportation and Forwarder

After a discussion of the problems, the interviewees made suggestions for better ways to choose the forwarder and the mode of transportation. A few of the interviewees in DC Trelleborg saw the present state of affairs as a functional method. Since there are only nominated forwarders behind the customer data in SAP, the selection is relatively simple. While the process may be functional and transparent, it nevertheless requires manual labor because the customer data needs to be updated periodically.

Another perspective that became apparent was that **the person placing the order would not need to know the nominations**. If the order desk and the logistics team are physically distant, communication concerning the choice of the most rational mode of transportation becomes more challenging. The logistics team can usually name the most optimal mode within a few moments. Ideally, the person entering the order would know only its urgency and based on it the selection of the mode of transportation and the forwarder would be

done automatically in the later stages of the order to delivery process. The choice could be left to SAP or MTG: **the system should inform**, for instance, if the order is too light for a truck, in which case the booking would be sent to courier company instead. Alternatively, there could be different **options in MTG**, and the selection would be made after the order has been packed. The automatic choice of the carrier by MTG should occur according to the delivery priority, weight and destination of the order. The system would calculate the number of orders going to a certain destination on a given day and choose forwarders accordingly. This would be a significant improvement in the ordering process: the amount of human errors would be reduced significantly. On a negative side, the final price of the delivery can be informed to the customer only after the choice has been made if regular prices have not been defined. The automatic selection of a mode of transportation and forwarder will be presented in more detail in Section 6.7. All breakdown orders would be handled manually.

The person entering the order could have different options for delivery services. The delivery times for standard and express services should be fixed. For example, 1–3 days by express services, and 4–7 days by standard services to a single destination. Thus, the price of the delivery would be known before the selection. A few customers want to know the exact delivery time in advance, whereas for others it is enough to know whether the order is express or standard. Presently, an order may cease to be urgent after the price of the express delivery is announced. The order desk should be able to determine whether a breakdown order is, in fact, a breakdown order at all. Solving customer's needs and the urgency of an order are vital.

The customer may wish for a certain mode of transportation for the delivery. In practice, **the system would give all the possible delivery options for a delivery during the order phase**. However, this is not possible if the master data is incorrect in SAP and the net weights are unknown. The system should be able to spot parts with deviant dimensions or weight. Because the system can be trusted to function, there is no need to check the order manually. The system should also give the price for the delivery. In short, merely the urgency needs to be known: the person entering the order does not need to make comparisons between the most suitable, fastest, or cheapest option, because the system is capable of giving the prices and delivery times.

The process should be straightforward: **the transportation options should not be too numerous**. All forwarders that are no longer used should be cleared from SAP because a smaller selection is easier to manage. This is important if the order entry continues to select forwarders. If European DCs were to use same forwarders, the selection would be more successful. On the other hand, a large number of forwarders also gives certain advantages: for each order, Metso Minerals can choose the forwarder that is the most optimal for it. In an ideal combination, only the most important forwarders are in use. Harmonization would make the process clearer.

According to one of the interviewees, only **the mode of transportation should be chosen when the order is entered**. After that, **the logistics team should select the most suitable**, fastest, and most inexpensive **forwarder.** The correct forwarder should be chosen according to the delivery priority, weight, dimensions, incoterm and destination so that SLA could be realized. If goods are late from suppliers, the logistics team could change the mode of transportation to ensure that the goods will be faster on site. If all locations were chosen a forwarder for every order themselves, they would have less choices and it would succeed. Now, when ICSOs, ISA orders, and ICPOs are in use, people in all locations cannot remember correct forwarders from each plant.

Inbound and outbound logistics need to be harmonized. Since purchasers cannot know the most optimal mode of transportation and forwarder for the purchase order, they do not choose them. Despite the fact that the order desk is not aware of the optimal modes of transportation or forwarders, it nevertheless chooses them in DCE, DC Düsseldorf, and to certain extent in DC Trelleborg and DC Mâcon as well. Nevertheless, shipments of inbound orders may be less than optimal even if the mode of transportation is chosen after the goods are ready for shipping. Arguably, inbound bookings could be more automated. A less complicated option would be that suppliers use MTG, and the updated templates could be a solution for selecting the correct mode. For example, MTG should guide the supplier to choose correctly by revealing the breakpoints.

In inbound logistics, the work of suppliers who ship orders by courier and truck could be facilitated if there were a forwarding agent ID in SAP. The ID would have two alternatives. The ID would tell that if an order weighs x-q kg, the forwarder is z, and if it is heavier, the forwarder is y. The alternatives should be visible on the purchase order to ensure that the supplier is able select the correct alternative. Presently, an order can have only a single forwarder, and the booking for this forwarder is usually made by the supplier. However, the choice may not always be the most optimal alternative. If the order is urgent but heavy, these facts should be separately mentioned on the purchase order. A second option could be the use of optional forwarders in MTG, with information of specified weight limits. Thus, it would be easier for suppliers to choose a forwarder.

In conclusion, the forwarder should be chosen according to the urgency and the requested delivery date of an order in MTG when the order is ready for shipping. Several interviewees emphasized that MTG should offer more support the choice of the mode of transportation and forwarder. The system should alert the user if the chosen mode of transportation or forwarder is not ideal, or suggest suitable forwarders for each order. If the system can fix erroneous choices or notify the user about them, it might even be able to choose the mode of transportation and forwarder independently. Finally, the choice of transportation mode and forwarder should be more transparent with less options. On the other hand, if there are less options, the service may deteriorate.

6.5 Development of the Deliveries and Warehouse Operations

The majority of the interviewees commented that the key issue in deliveries is the combination of **costs, delivery time, and delivery accuracy and reliability**. Of these, delivery reliability was mentioned most often. Delivery time is crucial for breakdown orders, whereas for standard orders delivery reliability is paramount. The order needs to reach the customer on time. The keys to a satisfied customer are an inexpensive forwarder, swift and competitive lead times, and first-class quality. The focus tends to change with time: in the past, the focus was on the price, whereas at the moment lead times and reliability are important. However, from the company point of view costs are important as well. Thus, quality is not only important but also a combination of these elements.

Two conflicting opinions arose during the interviewees. Some of the interviewees were of opinion that employees, regardless of their position or team, need to **be familiar with issues related to transportation**, such as incoterms. In comparison, other half argued that it is not necessary for people entering orders **to be familiar with logistics**. The mode of transportation should be chosen simultaneously with the order entry, whereas the logistics team should choose the forwarder according to the chosen mode of transportation and delivery priority. Thus, if the delivery is delayed for any reason, the logistics team has the possibility to change the mode of transportation. This enables a faster delivery because the customer should not be able to see that the order has been delayed in some phase. In addition, the picking list should contain the first promised shipping date in order for the warehouse be able to prioritize picking and packing of a given order.

Regardless of the stage on which the mode of transportation and carrier for an order are selected, the mode and forwarder are not always suitable for a delivery, mainly due to partial deliveries. If **the whole process** – such as the schedule for the availability of items, the correct net weights, and instructions for packing the order – **were visible at the moment the order is placed,** the choice of the correct mode of transportation and forwarder would be easier. Thus, **the truck services** – groupage, full load, and part load – **could be separated** as well. Presently, the order desk is not capable of making the decision. However, if the whole process were visible from the start, the order desk would be able to choose the optimal truck service. The selection process could be automated. The required information for automated decisions depends on in which the phase of the order the selection is done.

Checking for breakpoints is time-consuming. It would be useful to see the breakpoints directly from the system and be able to compare numbers. If the **prices and delivery times for different forwarders were simultaneously available** for each lane in MTG, comparisons would be easier. For example, if weight, dimensions and destination are given, MTG should be able to tell the delivery time and costs by using different, possibly nominated, forwarders. Based on a country and postal code, the system is capable of giv-

ing the favored forwarder. The nominated truck forwarder may have, for example, a minimum charge of 100 kilograms to a certain postal code. Thus, courier might be the most reasonable mode of transportation, even if the order weighed dozens of kilograms.

Packing should be developed as well. Metso Minerals should identify the materials that come from suppliers and are delivered to customers in certain size of batches. A well-made package that is suitable for the delivered items should be used by a supplier. Thus, the package can be delivered to DCE's warehouse without it needing to be opened, and the end customer will get the order in the original package.

If a shipment is created before packing, and the packing is done for a single shipment, deliveries into an individual address are consolidated. Thus, the mode of transportation should be decided according to the net weight. If there are routes based on weight already in SAP, the warehouse will have **guidelines for packaging**. The guidelines could include, for example, the following: orders under 30 kg are be shipped by courier, orders over 30 kg for export countries are shipped by air freight, and European shipments weighing over over 100 kg are shipped by road or, in the case of overseas orders, by ocean freight. However, given the different urgencies of goods, these weight limits are not always usable. If the mode of transportation were chosen after the order has been packed, knowing how to pack the order correctly would be challenging. A deeper analysis will be necessary before any strategy is implemented.

Consolidating deliveries for a single shipment in SAP would reduce transportation costs. The question is when a shipment should be consolidated. The aim is that MTG would make the final consolidation daily before cutoffs of forwarders. The shipments would be consolidated under a MTG reference, and the booking of the reference would then be sent to the correct forwarder. The forwarder would be chosen depending on the characteristics of the delivery. If there are several deliveries to a single ship-to address, they will presumably be booked for road or ocean transportation because of their shared weight. In comparison, when a single small package is shipped, a courier will be booked. On the other hand, if the shipment to an individual destination is large, the shipment should be split according to its weight to ensure that it is not too heavy for a container or truck. Cutoffs are timed differently for different forwarders which means that the ideal time for consolidation could be before any of the cutoffs.

MTG could be developed in several different ways. Firstly, all suppliers should be able to use MTG. Metso should have a better control of inbound logistics. A way to achieve more control is to organize all bookings in MTG. The **visibility** of bookings would be increased and the delivery date could be confirmed. Another suggestion for the development is transference of all documents via MTG. There should be less suppliers in use, and the suppliers should consolidate inbound bookings. Prime is not cost-efficient in all of the cases because purchase requisitions are placed after the need: shipping the goods together is insurmountable. **The booking templates** in MTG should be developed as well: thus, a

supplier could choose the correct forwarder for an order, and the booking would be done correctly. In addition, there should be **individualized names for different services** in MTG to avoid confusion. For example, express courier normally refers to a delivery by air, whereas express economy courier generally delivers the goods by truck. In addition, a courier flight can be confused with actual air freight.

When the order is booked in MTG, forwarders should send **a status** of shipment back **to MTG**. This would decrease a number of inquiries and increase reliability. In addition, MTG can send **a link by email or text message**. After the order has been shipped, the link would **contain tracking information** for the customer. The date of dispatch and ETA need to be known immediately; updates could be sent throughout the delivery process. Contracts with forwarders should require that IOD is sent to MTG after the shipment has been delivered. Afterwards, the customer should receive an update about the IOD. The work in SSOs would be facilitated, since questions of status updates are presently common. The invoicing process could be developed as well: invoicing would occur only after the order has been delivered, if the incoterm is DAP. This would be possible, if information about the status of the shipment were sent to logistics team as well. Forwarders should inform of all **shipments returned** to Metso Minerals' warehouses if the logistics team has not asked for a return. At the moment, the information may be lacking. Automated information concerning status changes or delays during a delivery would be vital for Metso to be a reliable supplier for its customers.

MTG should offer **reports** for several purposes. Real-time status reports from MTG should be available as necessary, for example per country or supplier. For instance, the purchase team may need monitoring reports by selecting criteria like suppliers, booking date, pick-up date, ETA and realized delivery. Management could benefit from the reports as well. The main reports could be collected as a dashboard solution to present a status of orders in each moment.

If **MTG could provide a loading list**, forwarders would not need to send the lists to warehouses. It would be easier to check which orders will be shipped on a given day, and all orders would be loaded. The loading would not depend on forwarders' lists. This would be an improvement, because the forwarders' lists may be incorrect if, for example, the forwarder has not received the booking. In addition, harmonization between different actors would be increased. Another proposal is that **MTG would provide a document** for the warehouse, which would mention the forwarder and reveal other loading details of orders. The warehouse could make a loading list based on the MTG document. A third solution could be that MTG would provide waybills or a list of waybills to ensure that the correct orders are loaded.

The quality of the master data affects numerous steps in deliveries and warehouse operations. If the master data is incorrect and documents are not corrected, sanctions in customs and elsewhere may be imposed on Metso. The master data, especially net weights

and dimensions of products, need to be correct for the packing instructions to be developed. It is crucial that after an order has been created, the required package can be checked. The system could contain information on delivery options, prices, and ETA. While Metso Minerals is not far from being able to inform customers about the delivery time window, there nevertheless is room for improvement.

System errors cause the process to become vulnerable. If there are, for example, problems with printing the transportation documents, orders may not be shipped. Integration of systems is important. **P4T, SAP and MTG should be integrated** to ensure the optimization of processes. In addition, it is crucial that all parties use the systems. For example, all documentation would follow the same format if the documents are retrieved from Metso's systems. It should be possible to transfer all data between systems, and the systems should be able to spot possible error situations. If automation is increased, monitoring needs to be increased as well. Systems need **updating, maintenance and continuous service improvement**.

More efficient metrics to follow forwarders' actions would help to improve one of the final steps of the basic order-to-delivery process. Metso has several requirements for its forwarders but is not able to follow the realization of the requirements. In addition, a step-by-step analysis of processes often helps in their continuous development. MTG calculates ETA and checks if it is realized.

A few development ideas concerning mostly deliveries will be presented below. Number 1 arose several times during the interviews, whereas the final idea was sparsely mentioned.

1. MTG development
2. Harmonization
3. Speeding up the process
4. Automation
5. Ownership of each step
6. Visibility
7. Master data
8. Analysis and development of the process
9. Development of packing
10. Consolidation of deliveries
11. Fewer suppliers
12. Taking the customers' needs into account
13. Key performance indicator (KPI) for forwarders
14. No exceptions
15. Proactivity
16. Knowledge of logistics and incoterms

MTG has a lot of potential to be developed. Several general issues are mentioned, such as harmonization, automation and visibility. There are also more surprising ideas, like creating key performance indicators (KPI) to forwarders.

6.6 Automation Facilitates Operations

One of the interview questions was that if the choice of the forwarder and mode of transportation were automated, would it reduce the interviewee's workload. Like automation in general, the question offered the answers "yes", "no", and "perhaps". The question was exclusively targeted to those employees who are responsible for the selection of the mode of transportation when placing an order or who make adjustments for the selected mode of transportation.

Arguments for speeding up the process touched on the problems in choosing the correct mode of transportation and forwarder. If it were possible for them to be chosen automatically, the logistics team would not need to check if the forwarder is correct, because they could trust that it is automatically correct. When the order is placed and the mode of transportation and the forwarder are chosen automatically, approximately 30 minutes per person per week could be saved. The period of 30 minutes includes checking forwarders, changing forwarders, reversing PGIs, canceling bookings, and booking shipments manually. The SSO has the opinion that the automation would save time.

Arguments against automated selection included the customers' demand to receive an order confirmation in order to be informed how their order will be delivered. Metso has detailed rules on choosing the mode of transportation and the forwarder. In addition, it is possible to select forwarders behind the customer data in SAP. A shared concern was the loss of knowledge on how to choose forwarders if they were selected automatically. For standard orders, it would be useful to check the most suitable and inexpensive ways to deliver orders. Thus, it would be possible to save money and keep customers satisfied. The system cannot always select the most optimal option; at times even the nominated forwarder is not the most suitable choice. If customers' needs were to differ from the choice of MTG, problems might arise.

Several of the interviewees stated that automation would be beneficial as long as the personnel would retain the possibility to amend details. Even after booking, an order can change from a standard order to a breakdown shipment. This would mean that MTG could not be utilized, since the employees need to make changes manually. The possibility of making manual shipments needs to be preserved. Furthermore, breakdown orders can never be booked automatically. Since automation allots time for monitoring, making adjustments and filling customer requirements, it would be useful to increase **automation** as much as possible.

6.7 Different Scenarios to Choose the Mode of Transportation and Forwarder

Before this thesis, there have been discussions at Metso concerning the possibilities of automated choice of the mode of transportation and forwarder. If this were implemented, transportation modes and nominations would be accurate. At the moment, orders are placed by employees who are not logistics specialists. Furthermore, they place orders to several plants which all have different practices.

In the first scenario, the forwarding agent ID is not placed in SAP when an order is placed. Instead, Truck, Air, Ocean, Courier Express, or Courier Economy is entered. MTG would choose the appointed forwarder on the basis of nominations to the transportation lane.

If the forwarding agent ID is replaced by Truck, Air, Ocean, Courier Express or Courier Economy in SAP; and the MTG were to choose the appointed forwarder, the expected outcome is that the workload is reduced and the process becomes more transparent. Thus, there would be no need to consider nominations in advance. In addition, special issues between different locations would not need to be considered. Based on the interviews, the employees are equally divided in their support or opposition of the scenario. With EXW or FCA orders, customers should have the authority to select the forwarder. Because breakdown orders need to be checked case by case, they have been left out of the scenario. In the present model, the forwarder is filtered, by either the order desk or customer, after which it is checked and, if necessary, corrected by the logistics team.

It is not necessary for the customers to know the location from which their order will be shipped. In order to implement the scenario number one described above, the work of the order desk would be simplified. The person entering the order would not need to know the nominated forwarder. The sales and service office and the order desk could choose the correct mode of transportation according to the urgency and weight of the order without needing to remember nominations. This would be ideal for units and users who constantly ignore nominations. Compared to the second scenario, one of the positive aspects of the first scenario is that when the mode of transportation is known, the warehouse would know how to pack the order. On the other hand, ensuring that the person entering the order is able to choose an accurate mode of transportation would remain a challenge.

Several of the interviewees commented that the first scenario would not add any extra value because nominations are easy to remember or can be quickly checked from the instructions. Choosing the correct mode of transportation is more challenging. In addition, one of two SSOs thought that implementing the first scenario would not offer enough benefits. In regard to choosing the mode of transportation, the selection between courier and truck has proven to be the most challenging choice. The scenario described above would not remove this challenge. Another problem is that customers often want to know

the forwarder. However, the second SSO was of the opinion that the first scenario would facilitate work considerably.

If the first scenario were chosen for implementation, there should be a possibility to change the forwarder if necessary. If the order is late, road transportation should be changed to a courier or special service to ensure that the order will reach the customer on time. The question is whether it is reasonable to choose the mode of transportation at the start of the process, if it can be changed when the order is packed and ready for shipping. It might be more useful to choose it after the order has been packed to prevent unnecessary work. The system should be flexible: if a customer does not trust for a certain forwarder, or if the transportation to a given destination by certain forwarder is not successful, adjustments could be made. In addition, price lists for different speeds of deliveries should be available: the customers could choose a delivery that is best suited for their needs. In an ideal case, the delivery dates for each transportation mode could be given in advance. In order for the scenario to work, all forwarders should be connected with MTG, and MTG would need to be updated.

The scenario number two is that the forwarding agent ID would not be placed into SAP when an order is placed. Instead, the ID would be placed in Metso Transportation Express or Metso Transportation Economy. MTG would choose the optimal mode of transportation and forwarder and for each delivery.

The second scenario raised significantly more positive than negative comments but several questions as well. A number of interviewees were of the opinion that the scenario would work well for standard orders. According to the majority of the interviewees, breakdown orders should be handled case by case. Thus, there would be no urgency to add orders to the manifest as late as possible. According to BusinessDictionary (2016d), a manifest is a transportation document which gives a summary of all the waybills for, for example, a vehicle. The manifest expresses several details, such as a consignor, consignee, destination and number (BusinessDictionary 2016d). At Metso, the manifest can be issued by MTG: it is used as a loading list in a warehouse. An interviewee suggested that breakdown orders could be taken into account in MTG as well, if Metso had a nominated taxi forwarder. There should be a price ceiling for taxi deliveries. If the price of a delivery were to exceed the maximum price, the booking could not be done without the customer's approval. It can be assumed that EXW and FCA shipments would be left outside of the scenario. If the customer pays the freight costs, the customer is entitled to select the forwarder.

There were several positive comments relating to the second scenario. If Metso Transportation Express or Metso Transportation Economy were entered instead of the forwarding agent ID into SAP, the transparency and usability of the process would be improved. MTG would choose the optimal forwarder and the mode of transportation. Based on the weight and urgency of the order, MTG would calculate the best mode of transportation

to a county or postal code area, after which it would choose the nominated forwarder of the decided mode of transportation. The order desk would only have to determine the urgency of the order, and enter basic information such as the delivery address. The scenario would reduce the workload at the order desks and reduce the vulnerability of ICSO and ISA orders. The person entering the order would not need to know the dimensions of the item. The scenario would reduce costs and save working time.

In the inbound process, suppliers would not need to consider weight limits because MTG would select the correct mode of transportation after suppliers have entered package details. The optimal and inexpensive vendors are chosen for this specific PO by MTG. Because the nominations and breakpoints are country-specific and fluid, MTG has a better understanding of them than the sales persons and the order desk. This means that the formulas need to be accurate, and updates must be carried out regularly. If the order is Express, MTG should choose the fastest possible transportation. With Economy orders, the forwarder is selected by comparing prices and delivery times. Orders that are going to a single destination and leaving on a certain date would be consolidated.

On the negative side, the interviewees feared that cheaper deliveries might raise delivery times. Another issue would be ensuring that MTG chooses the transportation mode and the forwarder correctly. One of the interviewees argued that customers want to know the forwarder in OA: the customer is informed if the forwarder is changed. If the customer does not accept the forwarder, Metso Minerals changes it and makes a new OA. Since this requires resources, it would be suitable that only the Express or Economy transportation could be selected. This would reduce the number of possible changes. If the scenario were implemented, and the service needs to be changed from Economy to Express, customers could see the change on the amended OA.

The discussion of the scenario attracted a large number of questions about, for example, the correct selection, delivery times, incoterms, consolidation of shipments, packing, loading areas in warehouses, hazardous materials, and booking dates. The main concern was how the implementation of the process works in practice. A relevant question is that in which phase the mode of transportation and forwarder would be selected: after the order has been packed and is ready for shipping or when the order comes in. Presently, choosing the mode of transportation immediately after the order has been placed would be challenging, because the master data is not correct so that net weights of all items are not correct. If the forwarder is chosen on the earliest possible stage, the selected mode of transportation may not be appropriate. In the following, selected issues from the interviews will be presented.

A few of the interviewees was of the opinion that it is not possible for warehouses to pack the orders if the mode of transportation is unknown. Presently, for most of the warehouses checking the mode of transportation is the first step, after which the decision how to pack the order is made. If the second scenario were taken into use for export countries as well,

the question is should all orders be packed as ocean shipments, which, as regards packing, are the most challenging mode of transportation. On the other hand, European shipments should be prepared for ocean shipments as well, because the order might be shipped further to an export country. If all orders were packed for ocean freight, a large amount of packing material would be required. If the mode of transportation and forwarder are not known before the order is packed, several of the Metso Minerals warehouses and Metso Minerals' outsourced warehouses should be rebuilt. Separate loading areas should be reserved especially for ocean shipments, and scanners should show the location of the order.

As regards to inbound transportation, would the supplier fill information of parcels into MTG, and the booking would be automated on basis of the information? Should the supplier place an urgency into MTG, or would it come from SAP? The numerous suppliers of Metso Minerals should be retrained. There were several questions concerning deliveries as well. One the questions was that should all incoterms be modified to CPT or DAP? Thus, all the bookings would be organized in the same way. When FCA orders are in use, they require a separate process. With express and standard services, delivery times should be known so that they could be entered into the system, after which the system could calculate the time when the order has to be ready for shipping. This would replace the current routes, where the forwarder is one of the influencing actors.

Customers need not know where their orders are shipped from, which means that delivery days would be informed as 3–5 days to an area by Express service, and 5–7 days by using the Economy service. This means that an order could be shipped from Sweden or the Netherlands but the customer does not need to pay attention to it. To other destination, delivery times may be 4–6 and 7–9 days. A service promise must be communicated to each destination: for example, Express means x days and economy y days. The price lists have to be available at least in MTG if the customer pays the freight or if the DAP pricing is not in use.

If the system makes the choice, limitations for each forwarder and contract have to be placed into MTG. The public holidays in destination countries, information of hazardous materials, need for a crane and other shipping information should be filled in the text fields in SAP, and be copied into MTG. One of the issues was the point when MTG would send the booking. Would it be a certain time and day? Would all bookings be sent at the same time, or would it depend on the forwarder? If it depends on the forwarder, how the consolidation of shipments would be carried out?

The majority of the interviewees preferred the second scenario to the better scenario. At the moment, selecting the mode of transportation and forwarder is time-consuming, possible corrections take time, and the forwarder may be incorrect. However, regardless of the final decision, every unit should have the same process, and Metso Minerals should focus on making the processes more transparent. It is essential to have a reliable system that is immaculately planned from the beginning. Any special circumstances have to be

singled out and analyzed before the implementation. In addition, it is important to decide the optimal forwarder for every type of order. Should the chosen forwarder be the least expensive, the fastest, the safest or the most ecological choice? To ensure that the process works as planned, efficient monitoring is important.

In addition to these two scenarios presented above, a third option arose in the interviews. The logistics team could select the mode of transportation based on the delivery priority and packing information. If **the current modus operandi plus the two scenarios presented** above were in use, the number of options might be too large and might lead to individual solutions. This would not be the best option because it might confuse the user who might be working under a pressure. There should not exist more than one way to select the mode of transportation and forwarder.

The most relevant information required for an automated decision is the payer of freight: is it Metso or the customer? If the payer is Metso, the ship-to address, incoterm, weight, dimensions and (non-)stackability of packages, chargeable weight and delivery priority are the key aspects which are placed into SAP. In MTG, the nomination and MRSs, where the delivery time and urgency are compared, would be essential. At the moment, the mode of transportation is selected in SAP; however, in the future MTG could choose the transportation mode. Weight, dimensions and stackability are placed in a warehouse.

The interviews took into consideration the most important and the easiest improvement task of the order-to-delivery process which could be executed at first. These include the correction of the master data, familiarizing suppliers with MTG, reports from MTG, faster putaway, better visibility for the orders and shipments, and sharing information between different locations.

6.8 Improvement of the Charging Freight Costs

Each interviewee was of the opinion that there should be **different costs for breakdown, express and standard orders** – either in parts or freight costs. Metso Minerals may suffer economic loss if the orders are not charged differently. If customers need the order fast, they should also be prepared to pay extra for it. For example, because breakdown orders and express shipments cause extra work, an additional percentage or sum could be added to an invoice of the orders. Several employees also thought that extra costs should be included in the price of materials if the order is breakdown or express. A breakdown fee could be a possible option, since in breakdown orders all steps of the process have to be carried out swiftly and mean extra work for the order entry team, the logistics team and the warehouse. This is especially important for MTO parts. If the breakdown order is also a MTO part, the production is required to stop everything else and start producing the MTO part. For this reason, the cost of a breakdown part should be higher. However, a few of the interviewees argued that customers should not be penalized for breakdowns.

As regards invoicing transportation services, the opinions were divided. A few of the interviewees responded that faster deliveries should be more expensive. If it is a percentage, it should be different for different modes of transportation. A rough estimation should be available to the customers so that they could see how much transportation in each delivery priority will cost. Other interviewees suggested that the freight cost could be charged according to its actual price. Most importantly, there should be shared rules for invoicing, and they should concern Metso Minerals as a whole. For example, **DAP pricing** could be used for all customers: a part price would include the freight costs. The cost could differ depending on the delivery priority. On the other hand, the payer of freight could be selected so that it would be a party to whom the costs of the cargo would be the least expensive because the amount of freight costs may depend on whether the freight is paid in the departure or the destination country.

7. ANALYSIS OF THE RESULTS AND DEVELOPMENT SUGGESTIONS

According to the definitions of supply chain presented in Chapter 3.1, a supply chain is a network, where different parties work together to process raw materials into finished products and deliver them to customers. The order-to-delivery process at Metso Minerals, which has been the main focus of this thesis, does not include acquisition of raw material. Otherwise, it contains the same elements as the defined supply chain. It was expected that while the current order-to-delivery process at Metso Minerals is satisfactory, it could be more cost-effective, and the quality could be improved. As mentioned above in Chapter 3, supply chains compete in time and quality (Mentzer et al. 2001, p. 2).

The interviews and observation gave a comprehensive picture concerning the current order-to-delivery process and its problems. The answers varied even within a single unit. This means that harmonization of processes and instructions would be vital. While all employees have a unique way of working, a company should have a set of general rules and recommendations. The aim is that improvement suggestions would be taken into use at Metso Minerals by organizing a development project for each development idea.

7.1 Similarities and Differences of the Process between Locations

The order-to-delivery process at Metso Minerals is perceived as transparent. There are more similarities than differences between the selected units. These similarities and differences deal with DCs and MRE: the process in sales and service offices is different. In the beginning of the process, Prime sends purchase requisitions to all of the units and Pool4Tool is in use in every unit. These are important systems for purchasers.

DCs and MRE use different order types. For example, MRE Düsseldorf does not have ICPOs, whereas ICSOs are in all of the locations discussed in this thesis. However, ICSOs are not identical: most of the units use ICSO blocks which need to be released before the order is passed to warehouse operations. DCE has stopped using blocks, and the process has become faster. DCE is the only location to use ISA orders for distributors. This makes the process at DCE faster, because it is not necessary to copy the order to SAP. STOs are not used in every location. Finally, there is slight variation in the customer segments between different units.

The units provide several different sizes of parts. DCE is the only of the units which sells mainly MTS products. MRE Düsseldorf does not sell hazardous goods. Scanners are used in all of the warehouses to make receiving the goods and picking easier and faster. SAP

can be used to check the date on which the goods have been loaded. These dates have been entered by the scanners.

The process in the selected units of Metso Minerals is automated or semi-automated. Several of the interviewees saw automation as a positive matter. For example, ICSOs ensure a more rapid process, because the order does not need to be entered twice into the system. All units have an automatic delivery creation. One of the most marked difference between DC Trelleborg and the other units is that DC Trelleborg does not use an automatic PGI creation, because post goods issue is made when the goods are shipped. SAP forms the shipment automatically in DCE and DC Düsseldorf, whereas in DC Trelleborg and DC/SSO Mâcon the shipments are created manually when the forwarder is chosen or checked. In addition, making export declarations and invoicing vary between the locations. An export declaration can be made by an external company, a warehouse or a forwarder. There are different invoicing methods and times between units.

As discussed in Chapter 3.1, according to Helo & Szekely (2005, p. 5), the objective of supply chain management is to focus on the total system performance instead of optimization of individual logistics phases. One of the main arguments of this thesis is that by improving the process gradually and by harmonizing the processes of the different locations, the order-to-delivery process can be comprehensively improved.

7.2 Major Problems and Development Proposals

In general, the process works satisfactorily. However, there are both larger and smaller issues that could be developed. Harmonization and automation are the main issues in the development of the order-to-delivery process. More specific development targets will be presented later in this chapter.

It should be noted that the order-to-delivery process has and will continue to have exceptions which may cause challenges, and which have to be taken into account. Detailed process descriptions for all sub-processes and exceptions should be made to ensure the availability of instructions and operating models for all users.

7.2.1 Master Data and Information Flow

Correction of the net weights and custom codes in the master data is vital: it is the basis for several other development projects. If the master data is not correct, order handling, packaging and deliveries cannot be performed to their full potential.

The information flow is one of the main logistical flows (Karrus 1998, p. 72, 310). At Metso Minerals, information flows well inside units. However, the information flow between units should be developed. The sharing of information between locations is im-

portant to avoid the same mistakes from being made twice, and to share information concerning good practices and innovations. Communication between Metso Minerals and stakeholders should be improved as well.

Faster response times are necessary for progress. The forwarders do not inform about delays or statuses of shipments as well as they should. They could, for example, send the status of a delayed order to MTG, which would, in turn, forward the information to the order desk – or even the customer – as a pop-up or an email. Information concerning status changes or delays during deliveries should be automatic or semi-automatic. Communication in general should be developed. Metso Minerals would also need general time limits within which the response is required. The hectic nature of the process means that updated information is constantly needed.

As mentioned in Section 3.1.1, according to Croom et al. (2000, p. 73), information technologies can aid the supply chain by providing transactions between parties in the supply chain. SAP and MTG should include all information regarding an order, and each party should be able to access the information in the systems. Ideally, the systems would tell to a warehouse's personnel how the order should be packed. This, however, requires that the net weights in the systems are correct. Warehouses should be able to edit net weights of material in SAP if they notice any errors. Thus, the percentage of correct net weights could be raised.

Metso Minerals should be able to inform its customers if there are any exceptions in the process: if, for example, the customer's order will be delayed. In addition, customers should have the possibility to follow their orders. In order for this to be possible, suppliers and forwarders should inform Metso Minerals about delays and statuses of shipments, Metso's different units and teams should keep each other informed, and Metso Minerals should inform its customers as well as possible. In order to ensure smoother communication, terms and abbreviations could be determined in the intranet. According to Croom et al. (2000, p. 73), the supply chain needs key data which is available in a designated place.

7.2.2 Material Flow

The material flow has several stages, starting from a supplier and ending to an end customer. Mentzer et al. (2001, p. 2) argue that customers require fast and reliable deliveries from companies. Due to globalization, companies have to coordinate the material flow more effectively than previously (Mentzer et al. 2001, p. 2). In order to be effective, the material flow should be shortened. For example, material should be available sooner, and deliveries should be direct whenever possible and reasonable.

In order for direct deliveries to become more common, Metso Minerals should develop a process description for direct deliveries. A person or a group of persons should be assigned to take care of direct deliveries and serve as experts in tax issues. Metso Minerals

should examine a few business cases to see if direct deliveries would be more cost-effective than the present methods and if they would bring added value to the service.

7.2.3 Orders

An order-to-delivery process starts when a customer needs certain goods (Forslund et al. 2008, p. 43). Thus, the ordering phase is one of the most important phases of the process. Harmonization of the order entry process in SAP is one of the principal improvement suggestions of this thesis. Metso Minerals should have a single order desk, which means that there should be one interface for ordering from any DC. Customers need not know from where they should order each part. Instead, they could order all the required materials simultaneously. As opposed to the present model, they do not need to remember all the different contacts.

An order should be placed only once, and it should be entered correctly at the first time. This would prevent mistakes in the ordering stage, and speed up the process. While the ICSO process is useful, the forwarder, route, and ship-to address are often wrong in the order. Harmonization and automation would help in this challenge as well. A ship-to address must be placed into an order since the system cannot know it. However, the forwarder and route can be placed automatically. ICSOs could be expanded outside of Europe which could lead to decrease in the amount of manual handling. In addition to harmonization and automation, templates to ICSO orders could be created for every plant to prevent different errors.

7.2.4 Warehouse and Packing

At Metso Minerals, courier, air, and truck shipments are packed in a nearly identical way, whereas packing for ocean shipments differs from other modes of transportation. According to Karjalainen & Ramsland (1992, p. 212–213), in all modes of transportation, the handling of material is similar in many respects and there are certain basic requirements for packages, regardless of the mode of transportation. If MTG were to choose the mode of transportation, warehouses should have instructions on how to pack each order. At the moment, the mode of transportation is one of the factors which affect packaging. If all orders were packed for ocean shipment, many packages would be overpacked. This would mean waste of packing material and cause extra charges. One solution could be that Metso Minerals would define certain destinations to which orders would be packed to withstand ocean freight.

An advantage of overpacking is that packages are safer and do not break during deliveries. However, a package can never be too sturdy for maritime transportation (Karjalainen & Ramsland 1992, p. 217). Metso should examine a few business cases to check that if packing costs would increase x%, how much would the transportation costs be increased.

If the mode of transportation or the forwarder is not known when the order is packed, it is impossible to know the time schedules. At the moment, one of the factors used to determine a route is the forwarder. If the forwarder is not selected, another way to prioritize packing in warehouses has to be developed. Fast transfers of STOs between the warehouses should be developed as well. When an order from manufacturing is ready, it should be made available for DC plant.

7.2.5 Deliveries

An order-to-delivery process can be evaluated by on-time delivery (Blackstone & Cox 2005, cited in Forslund et al. 2008, p. 43). Thus, deliveries have an important role in the process. Combination of costs, delivery times and delivery reliability gives a solid basis for deliveries. Of the three, delivery reliability is the most important.

Deliveries can suffer if a part is not in a stock when planned. If the order is standard, but the required material is not in a stock, it often changes to a breakdown order. In these cases, one of the challenges is to decide who should pay for the faster delivery if the order has been standard in the beginning. A way to solve the issue would be to ensure that the material was available on time; however, the method is not reliable. Logistics tries to minimize unnecessary transportation and storage (Tapaninen 2013, p. 34). This means that deciding which items are MTS and which MTO requires careful planning.

3PL providers, such as forwarders, are commonly used by organizations (Cheng et al. 2008, p. 466). For example, 3PL providers operate transportation for Metso Minerals. However, a few of the interviewees mentioned that Metso Minerals should use less forwarders, and the forwarders should provide better information about deliveries. The interviewees saw the numerous transportation services as a positive factor, but also commented that there may be too many options to choose from. If the selection were automatic, the amount of options would cease to be a challenge.

A better control over bookings should be developed. This would require that Metso Minerals would book the transportations or Metso systems would be used for booking. It might be beneficial if Metso Minerals were to use DAP and CPT incoterms exclusively, and arrange deliveries. Transportation costs could be included in the price of parts and DAP pricing could be in use for all customers. Thus, Metso Minerals could arrange the most optimal delivery for each order.

Metso Minerals should measure transportation more carefully and require commitment to the contract. As discussed in Section 3.2, the meters of service quality are typically related to availability, delivery reliability, and order-to-delivery delay (Karrus 1998, p. 120). The interviewees also mentioned that the delivery time mentioned in SLA is not long enough to organize deliveries to certain destinations. If it was longer, delivery times in general would be lengthy. SLA should be country-based, instead of being the same

within Europe – as it presently is. The fact that there are few departures per week to certain countries has to be taken into account in automated bookings and SLAs. The end part of the order-to-delivery process is not adequately followed. Forwarders do not always send IOD, which prevents Metso Minerals from knowing when the order has been delivered. Because of this, Metso Minerals may send an invoice before the order has been delivered to the customer. If IODs could be offered automatically, the invoice could be sent only after Metso Minerals has a confirmation that the order has been delivered.

7.2.6 MTG Development

MTG should be utilized more actively than it presently is. The system has potential, but its development is expensive. In the beginning of the process, it would be ideal if the majority of suppliers would book the inbound booking in MTG. Since suppliers have difficulties in choosing a suitable forwarder, MTG could, after package details and addresses have been entered to it, provide the suppliers with accurate options based on the inserted rules. If bookings were made in MTG, Metso would have a better control of inbound shipments. In addition to the suppliers, all nominated forwarders should use MTG. If they are not linked to MTG, they should be replaced. TMS can be used for several purposes. Transportation management system may be a way to plan the ways shipments could be picked up and delivered in a cost-efficient manner (Jauffred et al. 2005, p. 1).

All documentation between Metso and forwarders, such as invoices and export declarations, could be sent via MTG. MTG should be able to inform the users if a certain document is missing. Information of hazardous materials should be automatically passed to forwarders. The information could be available in the booking in MTG. Presently, flights and ocean shipments are booked in MTG, and documents and additional information are sent by email. In the future, MTG could take care of the whole booking processes. Furthermore, forwarders should return information about tracking number to MTG to improve monitoring. Metso could utilize MTG for the automated selection of forwarder and booking. Thus, deliveries or shipments could be consolidated. Ballou (1999, p. 261) argues that small packages can be consolidated to improve efficiency.

Prices and delivery times should be available in MTG. A comparison of prices and delivery times for all nominated forwarders in MTG would enable the choice of an optimal forwarder. The status information as well as automated information of deviations should be sent via MTG. The data in MTG should be updated constantly.

7.2.7 Freight Costs

Capital flow is one of the main flows of a logistics chain (Karrus 1998, p. 309). For the most part, this thesis concentrated on freight costs. Several different pricing principles are in use in different Metso Minerals locations. Breakdown, express and standard orders

should have different freight costs. The freight costs of all breakdown orders should be charged from customers. If customers are willing to pay freight costs, which may be hundreds or thousands of euros, their order is urgent. At times, it may not be possible to know if a customer has a real urgency with the order. If the need is not real, breakdown orders may waste a lot of resources, because each step has to completed as fast as possible. According to the interviewees, extra costs should be included in the freight or in the parts of breakdown orders. An ideal option would be that materials would be more expensive if the order is breakdown or express. The freight costs would be charged according to the correct price.

As a part of harmonization, each unit should use the same pricing policy for products and freight costs. At the moment, old instructions may be used if the freight costs are not checked from MRS or MTG. The freight costs may not be available at all. The outdated information is used despite the fact that freight costs change often.

A more effective way would be that Metso Minerals would arrange all the deliveries. One of the problems at the moment is that customers do not pick their EXW or FCA orders from a warehouse on time. Incoterms should be CPT or DAP: Metso Minerals would arrange a delivery and charge freight costs from the customer. DAP pricing is a useful way to charge freight costs by adding the additional percentage for the price of parts. Another way is that freight costs would be added automatically on an invoice.

7.2.8 IT and Automaticity

It is remarkable that human errors were mentioned four times, but system errors only once during the interviews. Automation evoked more positive than negative comments from the employees. Employees may feel that automation means loss of control, whereas in reality they just need to monitor operations more carefully than with manual processes. Metso Minerals has both automated and manual ways to monitor the process. In addition, it became apparent in the interviews that automation of processes was seen as a positive phenomenon by several interviewees. Initially, the employees did not trust automation, but changed their minds after successful implementation. Locations which have adopted automated processes have been satisfied with them.

Automation can satisfy the requirements set to it if it is well-planned. For automation to work, it is important that the data is accurate. Otherwise, errors can remain unnoticed in the background: fixing the errors of automated processes is challenging. Automation can quicken a process and decrease the quantity of human errors.

It could save time if the forwarder and the mode of transportation were chosen automatically. On the negative side, it may not be possible to customers' wishes could be met as well as they presently are. However, the process could be simplified considerably. At any

rate, the possibility of organizing special transportation in any phase of the process should be retained.

It is important that the systems are synchronized both inside a company and between the company and its stakeholder organizations (Evgeniou 2002, cited in Stefansson & Lumsden 2008, p. 58). In order to take advantage of systems as well as possible, the systems should be integrated. For example, alignment of P4T and MTG would facilitate the work of the suppliers. If suppliers used P4T correctly, they could use packing lists from P4T and the warehouse would receive the materials more smoothly.

7.2.9 Choosing the Mode of Transportation

The mode of transportation and/or the forwarder is selected when the order is placed to SAP. When the order has been entered, the customer receives an order confirmation. In this phase, the customer often informs if a faster delivery is needed. This should be informed immediately after the order has been sent, because adjustments demand unnecessary resources. Often the selection takes resources of two teams, the order desk and logistics. Currently, choosing the accurate mode of transportation is challenging, because Metso Minerals offers parts in several different sizes, and the net weights may not be correct in the systems.

The most important factors for selecting the mode of transportation are nomination, urgency and weight. None of the interviewees mentioned dimensions or volume weights which can affect freight costs considerably. Persons who have experience of choosing the mode of transportation tend to use their instincts. If the destination is unusual, they check the price difference between the modes of transportation. ICSO customers and others who place orders to several different locations use different instructions for different plants. However, breakpoints can change. The actual costs of deliveries or breakpoints are seldom checked for different modes of transportation.

The current status of the order-to-delivery process is problematic: the purchase team may be unable to choose the mode of transportation, since they may not know how the order will be packed. Furthermore, they do not know if there are other materials leaving from the same supplier on the same date. However, this should be known in outbound logistics, because the forwarder has to be placed when the order is entered. There are few errors in the transportation modes and forwarders, if the mode of transportation and forwarder are corrected after packing when necessary. However, this means manual labor and is time-consuming. If the choice of the forwarder is done when the order is placed, the situation can change, which in turn may result in further errors and mistaken choices.

Metso Minerals wants to be a customer-oriented company, which means that it wants to make ordering easy for its customers. Customers should not need to remember nominations. They should only be able to choose whether they want a standard or an express

delivery. If a customer needs a special delivery, it can be arranged. Reasons for automated selection will be presented below.

Errors may occur in several phases of the process. In the beginning, suppliers tend to book inbound shipments. The suppliers have instructions but may not follow them in sufficient detail. In addition, instructions consist mainly of the destination and weight. The urgency is announced by a separate email. In inbound or outbound logistics, instructions may not be updated regularly. A few of the suppliers and order entry employees use incorrect instructions because nominations change occasionally. People who place orders may become used to some of the forwarders and prefer to use them regardless of whether they are accurate or not. While ICSO customers receive instructions, the instructions may include outdated information. In addition, remembering all the options and rules presents a considerably challenge. Because of these facts, ICSO orders tend to have more errors than the orders which are placed from a sending location. Finally, different units have different ways of thinking. An employee may think that if a courier is selected for an order, the order is urgent. In reality, courier may have been selected because it is the most cost-effective way to send the goods. Even if the accurate forwarder is chosen, there might be post-deliveries which are not cost-effective.

Automation would prevent human errors. In addition, if an automated selection could be done in MTG, the adjustments would cease to take time. Customers should choose the transportation service in the beginning of the order. The freight costs and delivery times should be available in MTG for customers, the order desk, and the logistics team. A comparison of prices in MTG would help to choose the correct mode of transportation. This data has to be updated constantly. Information is vital for the decision-making in the supply chain, whereas information technology brings mechanisms for acquiring and analyzing information so that efficient decisions can be made in the supply chain (Chopra & Meindl 2007, p. 495).

As regards automation, EXW, FCA or breakdown shipments cannot be taken into account, because customers can choose how they want their order to be shipped. If automation were not implemented, any type of harmonization would help to prevent errors.

7.2.10 Metso Transportation Economy and Metso Transportation Express

In the first scenario, the forwarding agent ID is not entered to SAP. Instead, Truck, Air, Ocean, Courier Express or Courier Economy is chosen, and the MTG chooses the appointed forwarder on the basis of the information entered. The scenario returned an equal amount of positive and negative responses. Warehouses would benefit from the scenario, because they could optimize packing according to the mode of transportation. The order entry and sales persons would not need to know or remember nominations. Thirdly, it would facilitate work of people who place orders to several plants.

There are also disadvantages. Several interviewees pointed out that since the mode of transportation has to be chosen for every order, there is no extra value and it does not lessen the work of the order entry. In addition, how to guarantee that the correct mode of transportation has been chosen? If the order desk or sales persons can choose the mode of transportation, they should be able to choose the correct forwarder as well. If employees know the nominations, this option does not offer any extra value. In addition, it would not remove the most challenging choice: the selection between a courier and truck.

If Metso Transportation Economy and Metso Transportation Express could be placed into SAP instead of forwarding agent ID, and MTG would choose first the optimal mode of transportation and after that the nominated forwarder, all the parties in the order-to-delivery process could benefit from it excluding warehouses, because the mode of transportation would not be announced before packing. This scenario raised several positive comments, but questions as well. This would be the most user-friendly option. In addition, the interviewees thought that the scenario could be cost-efficient. The interviewees thought that MTG is more familiar with breakpoints than the orders desk or sales persons.

When Metso Transportation Express or Metso Transportation Economy are the two options, business has to select what customers are willing to pay to shorten delivery times. It could be, for example, a certain percentage formed on the basis of the Economy service. Customers should understand that speeding up the process, order handling, storage handling and fast deliveries cost more. The Economy option is chosen for standard deliveries. It is always the most inexpensive choice, but it can also be the fastest. If the delivery time is not shorter than in the Economy service, the Express option would choose the most cost-efficient mode of transportation. If the delivery time is faster than defined percentage of days compared to Economy service, Express service may cost a certain percentage more than Economy service. This can be also checked by the split-level. If the order can be delivered one day faster than the other option, it may cost a certain percentage more. If it is two days faster, it may cost a larger percentage more, and so on. Customers should be able to calculate delivery time and prices for express and standard orders in MTG. This will help them to choose the most optimal option for their order. They need to know the delivery times for standard and express shipments.

Because the scenario emphasizes the choice of correct and inexpensive forwarder, it places several requirements on the systems and the rules placed in the systems. For example, delivery priority, packing details, volume, chargeable weight, payer of freight, incoterm, ship-to address, non-stackable or stackable, and nomination have to be taken into account. In addition, MTG should be able to determine the frequency of departures. MTG could consolidate deliveries if booking would happen once a day per a forwarder. This would mean that there would be no negative effects caused by post-deliveries. So that it is possible that MTG chooses a forwarder, all forwarders have to use MTG, and MTG has to know contracts and limitations for each forwarder. Shipping instructions,

such as the opening hours or the need for special equipment, should pass to MTG from SAP.

The second scenario raised a number of questions which focused mainly on warehouse operations. The most common questions were that how the process would work in practice, and how warehouses know that they pack correctly if the mode of transportation is unknown. One of the concerns was that if every order should be packed for ocean freight, it would lead to overpacking and the waste of packaging materials. Another question regarding the warehouses was that how warehouses would be aware of time schedules if routes were not used anymore, or if they were used differently. In addition, the interviewees speculated how delivery times for standard and express shipments could be informed to customers.

If the second scenario were to be implemented, a detailed research would need to be carried out before the implementation. The system has to be reliable, and it needs to be planned carefully from the start. Several issues must be taken into account, examined, and solved in order to confirm that the change would be rational and cost-efficient. First, the current costs have to be calculated. Secondly, the costs of the new scenario would need to be estimated. If the current costs exceed the estimated costs, the new process should be implemented.

8. CONCLUSION

This study examined supply chain management, logistics and the order-to-delivery process. The main focus of the thesis was on the order-to-delivery process at selected units of Metso, its major challenges, and how they could be developed. The challenges were presented in Chapter 5, and development suggestions in Chapter 6. A more detailed analysis of the research results was presented in Chapter 7; only the main research results will be summed in this chapter.

Chapter 8.1 presents the research questions and provides answers to them. Recommended solutions are summarized in Chapter 8.2. The solutions are nearly identical to the topics for further research. In Chapter 8.3 the reliability of the survey is reviewed.

8.1 Answers to the Research Questions

The research problem was presented in Section 1.4. The main research question was formed from the research problem. The main research question was "**How the order-to-delivery process could be developed more cost-effective in order to improve the quality?**" This main research question was divided into five sub research questions which will be presented next, together with answers.

What is an order-to-delivery process?

An order-to-delivery process is a process which starts when a customer needs certain goods and ends when the goods have been delivered to the customer. The process contains, inter alia, customer service, ordering, logistics matters, forwarders and the supply chain. The order-to-delivery process has been presented in more detail in Section 3.1.2. Chapter 3 presents several subjects linked to the order-to-delivery process.

What is the current state of the order-to-delivery process at Metso Minerals?

While Metso Minerals' present order-to-delivery process works rather smoothly, there is nevertheless room for improvement. First of all, the process is not sufficiently streamlined. There are significant differences between the selected units of Metso Minerals. In some of the locations the process is highly automated, whereas in other locations reliance on manual work equals inefficient use of resources. Since the customer is valued high at Metso Minerals, the company has several manual processes which help to realize the customer's needs. The opinions concerning the order-to-delivery process that are based on the interviews have been presented in Section 5.1. Chapter 4 discussed the present order-to-delivery process at the selected units of Metso Minerals. The pros and cons of the process were the main topic of Chapter 5.

How the mode of transportation and the forwarder are currently selected?

There are differences in the ways the mode of transportation and the forwarder are selected in different the locations of Metso Minerals. For the most part, suppliers book the transportation by using Metso's agreements for inbound shipments. At the moment, the mode of transportation is selected when the order is entered to SAP. In several locations, the forwarder is chosen simultaneously. However, in a few locations the forwarder is chosen when the order has been packed. The forwarder and the mode of transportation can be adjusted until the order has been loaded at a warehouse. When choosing the mode of transportation and the forwarder, the main features of the order which are taken into account include nominations, urgency and weight. Section 5.5 demonstrated how the mode of transportation and the forwarder are currently selected in different units of Metso Minerals.

What kind of problems there are in the present order-to-delivery process?

Chapter 5 focused on challenges of the order-to-delivery process at Metso Minerals. The majority of them are repeated in the following list:

- General
    - Non-harmonized processes
    - Exceptions
    - Manual actions
    - Same data placed twice
    - Human errors (ICSOs contain more errors than SOs)
    - Amendments
    - Incorrect master data
    - Amount of emails
    - Missing control
    - Monitoring of orders
    - Non-agile systems
- Transportation
    - Suppliers do not use MTG
    - Gap between ordering of parts and services
    - Prices and delivery times are not easily available
    - Difficulties in the choice of the forwarder: unknown packing method and weight, surplus of options concerning the choice of the mode of transportation and the forwarder, nominations, the differences in the process between locations
    - Post-deliveries
    - FCA/EXW shipments are not collected
    - Low visibility
    - Forwarders may not give information on deviations

    - Lack of meters
- Warehouse and packing
    - Damaged parts
    - Delays or errors in goods receival
    - Inventory discrepancies
    - Prolonged ODR handling time
    - Picking related problems
    - Packing related problems
    - Errors in the packing information
    - Delays or errors in loading
    - Lost parts
    - Loading and unloading areas
    - Drivers may lack pick-up references

The challenges have been divided into three categories: general, transportation, and warehouse and packing. General challenges may occur in any phase of the order-to-delivery process. Since the main focus of this thesis was transportation-related issues, problems in transportation, warehouse operations and packing were presented in more detail.

How the order-to-delivery process could be further developed?

The major suggestions for development are listed below. The list is in a chronological order based on the order-to-delivery process. First general ideas are presented, then inbound related suggestions and later development ideas of orders and deliveries. They have been discussed in more detailed in Chapter 6.

- General
    - Harmonization
    - Automation
    - Correction of master data
- Inbound and IT
    - Suppliers should use MTG
    - Facilitated booking process in MTG for suppliers
    - Alignment of P4T and MTG
- Orders
    - Single order desk
    - ICSOs expanded outside of Europe
- Deliveries and IT
    - More deliveries arranged by Metso Minerals
    - Metso Transportation Economy and Metso Transportation Express in SAP instead of forwarding agent ID
    - MTG development
        - Documents

        - Information of hazardous materials
        - Comparison of prices and delivery times in MTG for all nominated forwarders
        - IODs to MTG
            - Automated information of deviations
        - Consolidation of deliveries
        - Automated selection of forwarders and booking
    - Shared pricing policy
    - Improved measurement of transportation and ensuring that the obligations of contracts are fulfilled

In addition to the suggestions mentioned above, several others exist. The aim of the list is to summarize the most important suggestions on the basis of the interviews.

8.2 Recommendations

The next step is to investigate and implement the development ideas into the order-to-delivery process at Metso Minerals. All of the ideas should be investigated further before implementation so they may be topics for further researches. Each suggestion requires its own project, in which the topic will be examined thoroughly. Before any of the developments projects is started, business cases and the amount of possible savings and improving of quality should be calculated.

One of the issues that should be examined is the degree to which the processes of distinct units of Metso Minerals differ from each other, and how they could be harmonized. The pricing policy is an example of harmonization. In addition, the amount of manual labor should be decreased: automation should replace those operations. This means that monitoring would need to be improved as well. In addition, the project for the correction of the master data should commence as soon as possible. Without it, it is not possible to implement other development projects which require correct master data.

As regards orders, DCs should have a single order desk to ensure that the communication between Metso Minerals and customers is more comfortable for customers. If ICSOs were expanded outside of Europe, the amount of manual labor could be reduced and mistakes prevented. Metso Minerals should try to get all suppliers to use MTG and P4T to ensure uniform methods of working. In addition, by arranging more deliveries on behalf of customers and suppliers, Metso Minerals could establish better control over them.

The next development projects related to MTG could be the following: transportation documents could be transferred via MTG, information about hazardous materials should be sent to forwarder via MTG as well, prices and delivery times should be visible in MTG, and comparison of prices and delivery times could be done in MTG for all nominated forwarders. MTG should be able to consolidate deliveries and select the forwarder for a

booking automatically. Testing of consolidation of deliveries could be started, for example, from STO and ICPO orders.

The transportation optimization solution, which would improve the order-to-delivery process, might be the most complex idea for development which materialized during the writing of this thesis. The idea would require a significant amount of further study and development. It could improve a selection of the mode of transportation and the forwarder for an order by choosing Metso Transportation Express or Metso Transportation Economy – instead of a forwarding agent ID chosen by an employee. MTG would choose the correct forwarder for the delivery according to certain preset rules. The scenario would bring considerable added value to the order-to-delivery process because it would save time in several teams and transportation costs would be lower by selecting the optimal forwarder. In addition, customers would receive their urgent orders fast and standard orders in the most economical way. Orders would not contain as much errors as earlier which leads to the fact that the orders will not get blocked.

As presented in Chapter 6.7, the first improvement tasks of the process could be the correction of the master data, familiarizing suppliers with MTG, better visibility for the shipments, receiving reports from MTG, faster putaway, and sharing information between different locations. These are the most reasonable or easiest to implement first. Instead, automatic transportation selections and an establishment of the single order desk, need careful analysis. The order-to-delivery process in general may contain several possible sub processes to be automated or harmonized. If all of these are wanted to examine, it will take time. However, new processes do not need to be implemented, or even researched, at the same time.

8.3 Assessment of the Reliability of the Research

The reliability of the qualitative research can be evaluated from four perspectives: credibility, transferability, dependability and confirmability (Lincoln & Guba 1985, p. 189). While researches tend to aim for accuracy, the reliability of results may vary. Therefore, the reliability of the study should be evaluated. The reliability means the repeatability of the measured results. The results of a research should not be coincidental. Validity, in turn, refers to the ability of a meter or a research method to measure exactly what it is supposed to measure. Meters do not always correspond to reality. At times the respondents may understand questions differently than they are intended. The reliability of the qualitative research can be improved with a detailed description of how the study has been conducted. The conditions of production of material, such as the location of the interviews, spent time, possible distractions and assessment of the situation should be described in detail. (Hirsjärvi et al. 2007, p. 226–227.)

This research can be considered as credible, because the interviewees were located in various units of Metso Minerals and had different responsibilities. Because the interviews

were semi-structured, the interviewees had an opportunity to answer transparently and diversely to the questions. Furthermore, since the subjects of the interview were sent to them by email in advance, they had time to prepare for the interviews. The interviews were recorded as well. Quality assurance was done in the end of the interview – provided that there was enough time after going over all the questions. If an interviewee commented that a particular question was not comprehensible, the question was revised for the next interview.

Transferability is satisfactory, because the scope of the research has been detailed described. The research can be repeated, because the interview questions are presented in the appendix and observation can be carried out at any time. Since the processes in companies tend to change constantly, the research results can be depended on for a limited amount of time. The order-to-delivery process has been described and analyzed in its current state. In addition, the challenges, and the development ideas based on the challenges, may vary between companies as well as even units. Confirmability is on satisfactory level. The answers of the interviews were not guided. However, in semi-structured interviews, subjective opinions may have arisen. In addition, the research contained observations. The observations were aiming for objectivity. Nonetheless, the interviewer's personal preconceptions of the partially familiar process may have affected the results. The assumption is that observations, combined with the results of the interviews, make the research reliable.

The literature review of the research can be argued to contain all the elements as defined by Lincoln & Guba. The review contained both contemporary and earlier scientific papers and different texts on a variety of topics. References to the source materials have been made correctly, and the references are presented in detail. The topics of the literature review can be approached from several different perspectives.

This research offered a comprehensive picture of the order-to-delivery process of selected units of Metso Minerals. Several problems in the order-to-delivery process were discovered during the research. Finally, development ideas for the challenges were collected as planned at the beginning of the thesis.

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APPENDIX 1: THE INTERVIEW QUESTIONS

Background (answers before interview by email)

- Tell about yourself briefly.
- What is your education?
- What is an organization you belong to?
- What is your position?
- What is your job description?
- What are your main responsibilities?
- What task takes the most of time in your work?
- Do you have an experience about the same kind of work as you are doing at the moment?
- What types of projects do you have?

Order-to-delivery process currently at Metso

- **Order-to-delivery process**
- Could you describe the order-to-delivery process in your organization?
    - Probably it would be better that one person describes the process before the interview(s).
- Presentation of the generalized process (the figure).
    - What do you think about the figure?
    - Is there something missing or would you add or change something?
    - Where you (your tasks) are in the process figure?
    - What your job tasks include?
- How do you see the order-to-delivery process at Metso at the moment?
- What are positive aspects of the process at the moment? Mainly regarding to transportation.
    - More specifically regarding to delivery cost and time.
- What are problems of the process at the moment? Mainly regarding to transportation.
    - How does the problem occur?
    - What does the problem cause?
    - Do you have any idea how to fix the problem?
    - Where an impact would be seen?
        - For example better lead time of the process, lower costs or less correction of errors.
- What is a matter in the order-to-delivery process which requires the most unnecessary resources?
- What is a task in your work which takes the most extra time, and you could make it faster or easier way?
- **Ordering**
- How does a customer order material? What is a tool (email, fax, phone etc.)?

- What a sales person do after (s)he has received an input from the customer?
- Who enters an order into SAP or where the details come from into SAP?
- Does a customer inform all needed information at the first time or do you need to ask more detailed questions from him?
- What information a customer needs to tell that a perfect order can be placed?
- Who knows a delivery priority and choose a mode of transportation?
- How often do you need to amend an order after creating it for the first time?
- **Deliveries**
- What is a role of transportation at Metso?
- How do you choose a forwarder and a mode of transportation at the moment?
    - Gut feeling / knowledge etc.
    - What data is needed for the selection?
    - Is the selected mode of transportation always the most rational?
    - How much time do you use for choosing the mode of transportation and the forwarder?
        - Including an email conversation with the customer, a contemplation what is a good transportation mode, changing the transportation mode later on etc.
- What are the problems when choosing a forwarder and a mode of transportation at the moment?
- What would be a better way to choose a forwarder and a mode of transportation?
- What kind of errors may happen during the process regarding to transportation?
    - What does the error causes in each situation?
    - How the error can be corrected?
    - How the error can be corrected so that the same error would not repeat?
- Are shipments well monitored?
- **Cash flow**
- How freight cost is charged from a customer and how from an end customer?
- Do you charge freight cost from the customer in all standard deliveries?
- Do you check and charge freight cost manually?
- When freight cost is charged?
- **Warehouse / packing**
- How much time a warehouse can use average for packing one order?
- How much time it uses?
- How material is packed if a mode of transportation is known?
- Is it essential to know how (a mode of transportation / a forwarder) an order will be delivered?
- If a mode of transportation is not known before packing, how an order would be packed then?
    - In this case, will there be much waste packing material and excess weight of packages?

    - How greater savings could be achieved: the correct packing or the correct mode of transportation?
- How much time the warehouse would use average for packing one order if a mode of transportation is not known before packing?
- **IT Systems**
- What systems, which have an impact on deliveries, do you use?
- What systems are connected with each other?
- What data can be transferred from one system to another?
- SAP
    - What information relating to deliveries is placed into SAP?
    - Is it possible and workable to place a requested delivery date (the latest possible delivery date) into SAP?
        - The customer should be informed that a faster delivery is more expensive.
    - What kind of errors may happen relating to an order in SAP?
        - From placing an order to invoicing.
        - What is done during error situations?
- ISA
    - What information relating to deliveries is placed into ISA?
    - What kind of errors may happen relating to an order in ISA?
- MTG
    - How data is transferred from SAP to MTG and then to other systems?
    - What kind of error situations may happen when transferring data?
        - How to solve the situation?
        - How errors could be prevented?
- Does automaticity increase the sense of reliability or unreliability?
- **Information flow**
- How information moves inside the organization and between the organization and stakeholders?
- What are your stakeholders?
- How is information flow at Metso at the moment?
- How information flow could be improved in the organization and between the organization and the stakeholders?
- How information flows from a customer to the order-to delivery process?
    - If the customer has requested a fast delivery, does this information reach a warehouse, a person who arranges a delivery and so on?
- What information do you use regarding to the order-to-delivery process? Where do you receive information from? How do you receive information?
    - Related to your own tasks.
- Who are people/stakeholders which you inform? What information you forward and how information is forwarded?
- **Material flow**
- How is material flow currently at Metso?

- What problems of material flow occur at the moment?
- How material flow could be improved?
- **Customer feedback**
- What kind of feedback you have received from customers?
    - Positive and negative.
    - From general and delivery point of view.
- What kind of market analysis you have done if any?
    - What is Metso's delivery performance compared to competitors?

Development ideas

- How the order-to-delivery process could be developed to be more clear from a perspective of transportation?
- How the order-to-delivery process could be developed to be more invulnerable from a perspective of transportation?
- Could deliveries be planned better?
    - How?
- If a forwarder and a mode of transportation would be chosen automatically, would it facilitate your work?
- What is the most important thing in deliveries: costs, delivery time, delivery reliability/accuracy or something else?
    - Why?
- What is your option, should freight cost be charged differently for breakdown, express and standard orders?
- Could express orders have a standardized additional freight cost (%)?
- What do you think about a scenario that a forwarding agent ID would not been placed into SAP when placing an order but Truck, Air, Ocean, Courier Express or Courier Economy instead?
    - MTG would choose an appointed forwarder.
- What do you think about a scenario that a forwarding agent ID would not been placed into SAP when placing an order but Metso Transportation Express or Metso Transportation Economy instead?
    - MTG would choose the most optimal forwarder and mode of transportation.
- If all, a current way and those two above mentioned options, would be in use, is there too many options?
- What information is needed for an automated decision?
    - What fields you should fill (in SAP or in some other system) which have an impact on choosing a correct forwarder and a mode of transportation?

Quality assurance

- What do you think about the interview?
- Was the interview successful?

    - If not, what would you do in a different way?
- Were the questions understandable?
- Do you have any comments or questions?